GOVERNMENT CONSULTATION - ACROSS BEACH OPERATIONS IN THE SMALL-SCALE FISHERY

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PREPARATION OF THIS PAPER

This is the fifth in a series of engineering reports based on Studies, Study Groups or Government Consultations organized by the Civil Engineering Group (formerly the Fishery Harbours Section) of the Fishery Industries Division of the Department of Fisheries, Food and Agriculture Organization of the United Nations, to consider problems met with in the development of the fishery industries of our Member Nations.

The problems considered in this report are a number of those related to across-the-beach operations in the small-scale fishery, identified by a previous Study Group, based on which Technical Paper No. FIII/T136, "Small Harbours and Landing Places on Difficult Coasts", was published by FAO, Rome, in December 1974.

Participating Specialist Consultants were as follows:

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2. Mr. H.A. Delap, Ireland
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PREFACE

In the present world fishery situation with its widening fishery limits, a change in emphasis is taking place with an uncontested exploitation of fishing grounds laid open to the local small mechanized boat fishermen that was never before available to them.

These changes should in most cases lead to a great improvement in vessels, gear, equipment and services in the small-scale fishery sector, to enable it to meet the challenge of the coming years.

A lack of service facilities of all kinds, however, has been one of the principle restrictions to the growth of existing industries in this sector. The lack of facilities would be still more pronounced with an increase in vessel size, the introduction of more powerful engines, new gear and the consequential handling and disposal of considerably larger total fish landings, all of which would be inevitable in an extension of the fishing grounds.

Site characteristics have set an almost impenetrable barrier to the development of adequate services in many of the existing beach-based operations. It was the objective of this group to attempt to break through the barrier and provide reasonable solutions in a number of specific situations.

The solutions discussed are not always in the civil engineer field; the naval architect-boat builder and the marine mechanical engineer have also much to offer.

It is to be hoped that the publication of this Report on the Government Consultation will bring a better understanding of the many problems encountered, and demonstrate how a few of the difficulties may either be circumvented, or reasonable solutions proposed.

The Secretary

GOVERNMENT CONSULTATION - ACROSS BEACH OPERATIONS IN THE SMALL-SCALE FISHERY

First Welcoming Speech by H. Watzinger
Director, Fishery Industries Division

Across Beach Operations

Let me first welcome all our visitors to Rome, and express the hope that you will have a pleasant visit and fruitful discussions.

Many of you are familiar with the structure of FAO's Department of Fisheries and the scope of its work; for those who are not, I draw your attention to the brochure "Fisheries Development for the Future" and to the Organizational Chart of the Department, which are included in your documentation and which describe our resources and functions more adequately than I can. We will, of course, be pleased to clarify any queries you may have in this connection. Let me just say that we in the Fishery Industries Division have responsibility for small-scale fisheries development and, in the context of this meeting, the engineering aspects associated with such development.

On the question of small-scale fisheries generally, I think it would be useful - even at the risk of repetition - if I were to say just a few words on why we regard this as a priority sector for assistance, and what our present role is in providing this assistance. The small-scale fishermen of the developing world can be numbered in millions; they are a major food fish production sector and in many developing countries are the only suppliers of food fish, and they will continue to be so. At the same time, these fishermen and their families number amongst the world's poorest, they often live in remote locations with few, if any, social amenities, and face appalling difficulties and often natural hazards in catching, landing and disposing of their fish.

Our governing and advisory bodies have given us the strongest possible mandate to intensify our assistance in small-scale fisheries development. Our strategy, which again has been endorsed by these governing and advisory bodies, aims at developing a series of regional projects which will assist member governments in formulating their policies for small-scale fisheries development, planning integrated development projects with equal stress on both technical and social objectives, and mobilizing technical and financial assistance for these programmes.

In all this, I believe that the mobilization of funds for well-formulated projects with sound, realistic objectives is perhaps the easiest task. The most challenging - but also rewarding - may be finding and introducing the adaptive and innovative technologies which will help the small-scale fishermen overcome their problems. There are several aspects demanding attention - for example - improvement of vessels on which new fishery methods can be inaugurated, improved handling, distribution, marketing and processing of the landed products, especially on-the-job training in all aspects of industrial development, and finally, provision of landing and shore facilities frequently lacking due to the hazardous coastal conditions, or lack of funds at this level of the industry to enable a viable operation to be conducted. This Consultation deals principally with the last items, but will also deal with a number of alternatives to the conventional landing places, whether it be a special beach landing vessel, or such as boat lifts or beach-based hauling mechanisms. On the other hand, you may well conclude that there is no need to conjure up new technologies - perhaps the right ones already exist and it is merely a matter of giving them wider application.

In any event, I hope that in your discussions you will take the opportunity to consider these matters and give us the benefit of your experienced ideas. At the same time, it is also important to keep in mind the objectives of this meeting, as set out on page 3 of background document No. 5, which, briefly, are:

(a) to summarize existing information and experience with operations of small-scale fisheries based on difficult coasts;

(b) to identify those areas where FAO should concentrate its efforts; and

(c) to advise on the formulation of long-term work programmes for these problem areas which could be carried out by FAO in collaboration with appropriate donor agencies.

I suppose it is inevitable, but none the less regrettable, that a large organization such as ours gets a little set in its ways and then becomes slow to adapt. This is why we need periodic Consultations such as this, from which, in this case I am sure, fresh ideas will come forward which we can incorporate in carrying out our development programme.

I think that is all I can usefully say except, perhaps, to reiterate the comments of the FAO Council which, meeting in Rome in June this year, stressed the importance of intermediate technology - as opposed to advanced technology - as a major stimulus to development, and their advice is certainly appropriate in the field of small-scale fisheries which you will now be discussing.

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Second Welcoming Speech by W.P. Appleyard
Chief, Fishery Industries Development Service

Firstly, let me say how very pleased I am to see you in Rome, and I do wish you every success in your deliberations in considering the problems of beach operations in the small-scale fishery sector. To me, the concept of this meeting fits in extremely well with our rapidly expanding FAO small-scale fisheries programme. For too long, some developing countries were inclined to leave the small-scale fisherman to his own devices feeling that, whilst he did not put too much into the economy, he did not take much out of it. Also, there was a great emphasis on the development of fisheries at an industrial level. However, this thinking has changed in recent years, either because of a greater awareness of social problems or because of political pressure. Many countries are now facing up to their responsibilities as to where the small-scale fisherman fits into the economy. There is so much to be done for the small-scale fisheries sector, and I will deal with some of that a little later in the meeting, when I shall be speaking more specifically on the small-scale fishery policy of FAO. In this room today, there is perhaps as much competence as can be assembled in one room to deal with the vexed question of landing fish on difficult beaches. I think all of us are particularly pleased that we have participation from the developing countries by way of Peru, Malaysia and India. At the same time, all of you have significant experience in working in matters concerning small-scale fisheries development. I would make one special plea to you. Your discussions are bound to develop at quite a technical level because you are all highly competent professionals, but please keep asking yourselves how these discussions may benefit the small-scale fisherman and his problem of landing on difficult beaches.

I have had the pleasure of working with some of you in other parts of the world, and I am sure that Mr. Gifford and our friends from Peru will well recollect the wave conditions at places like Santa Rosa and San Jose. When anybody talks to me about difficult beaches, I think of the poor small-scale fishermen and, indeed, their families, lugging boats through at least 20 meters of violent surf and breaking their backs every time they do it. And so, I hope you will really focus your attention as to how the man on the beach may benefit. Obviously, out of this week's meetings, everybody is going to improve their professional capacity, but I do emphasize that the object of this meeting is to benefit the small-scale fishermen of the developing countries.

Bill Cuckian has already informed you that the agenda is very flexible. This is good news, because it should encourage a free discussion which I hope will lead to some concrete recommendations and actions. Also, I hope that the Department of Fisheries of FAO, when you have all returned to your homes, will be quick to follow up these actions and prepare an action programme, so that we do not finish up with just another report to put on the shelves. Nowadays, we have a much better mechanism in the Department of Fisheries of FAO for getting over the results of your deliberations to the field, and when I describe our small-scale fisheries strategy I will explain to you how that can be done.

In conclusion, may I associate myself with Mr. Watzinger's words of welcome. I hope you will have an interesting and productive time in the conference room, and equally so I hope you will have a very enjoyable stay in Rome. As a start, I hope you will join me this evening for cocktails at my home, and hopefully you will have received invitations. Even more hopefully, transport will have been arranged. Good luck to you in your deliberations, and I shall be most interested in seeing the outcome. Thank you very much Mr. Chairman.

1. INTRODUCTION

Opening Proceedings

The Government Consultation on Fishery Harbour Planning (FHP/75/1) dealing with Across Beach Operations in the Small-Scale Fishery was held in the offices of the Department of Fisheries, Food and Agriculture Organization, Rome, commencing on 1 July 1975 and terminating on 8 July 1975. The first introductory meeting consisted of dealing with the first three items on the Agenda (Annex II).

Item 1. The opening of the Consultation was conducted by Mr. H. Watzinger, Director, Fishery Industries Division, in the form of a welcoming speech, a transcript of which is on page (v) Other explanatory talks were given by Mr. W.P. Appleyard, Chief, Fishery Industries Development Service, Fishery Industries Division - see page (vii) - and by Mr. W.J. Guckian, the Consultation Secretary, whose remarks are summarized in the Preface.

Item 2. The Agenda presented to the Consultation was unanimously adopted by the members present.

Item 3. One candidate only was proposed for the post of Chairman, Mr. S.J. Shiel. He was proposed by Mr. W.P. Appleyard and seconded by Mr. C.J. McGrath. Mr. Shiel was unanimously elected.

With Mr. S.J. Shiel in the Chair, the Consultation then proceeded with the programme of technical Sessions.

2. SESSION I

Consideration of Coastal Engineering Problems Affecting the Development of Small-Scale Fishery Operations: Introduced by Professor P. Bruun

Professor P. Bruun

In a talk dealing with across beach operations in the small-scale fisheries, the first consideration should be the beach that we have to cross. There are various kinds of beach in the world, some rocky, some stony or sandy. Rocky beaches are not very good for landing on, and where they occur one tries to put the landing facilities in some other place, a gap or bay or inlet. The beaches that we are mainly concerned about in the small-scale fishery are beaches composed of sand - and a major part of the world's shorelines are in this category. Such beaches raise many problems. Most of them are located on exposed shores - where wave action can be rather heavy. They are generally subject to tidal action and, not least, they are exposed to littoral drift, with sand migrating up and down the shore - sometimes in very large quantities. This has always been a problem wherever it is proposed to build on a sandy shore. There is a striking example of this very close to Rome, in the old sea coast harbour of Ostia, built nearly 2 000 years ago, a monument to the great ability of the people who lived here. They were aware of the problem and tried to avoid it by making open arches in the jetties and breakwaters, believing that the sand would pass through as it did for a time - but today the harbour at Ostia is quite a long distance inland, an example of what can happen when something is built out from a sandy shore.

One can try to cope with this kind of open-shore problem in a number of ways. It can be avoided by locating the landing facility in a bay which is not exposed to the worst effects of this kind, or by moving into an estuary. The first ports in the world were probably located in estuaries (exceptions to this were at Tyre and Sidon - in what is now Lebanon - which were built right out on an open coast, constructed of very large artificial blocks of a type of concrete, keyed together with copper dowels to make them heavy enough - a fantastic proof of what they could do in those days). Later, the idea grew of erecting harbour structures far out in the open sea beyond the breaker zone, to provide some sort of

island port, connected with the shore by an openwork trestle. This was very expensive and left a number of problems unsolved, since such offshore harbours tend to connect themselves with the shore by accumulations of sand (tombolos), causing problems to the harbour itself as well as to the adjoining shores, particularly on the downdrift side. Certainly this type of solution is well outside the relevance of small-scale fisheries.

Between 50 and 100 years ago most of us were developing countries so far as the fishery industry was concerned, so that a study of this history will give us an indication of how development has taken place. Every country with a sea coast had small row or sail boats. On the North Sea coasts of England and in Holland and Denmark they were able to use these boats, bringing them through the surf and landing on the beach. As time went on they tried to improve conditions where possible, by putting the ports where the natural conditions permitted.

Let us consider what we are aiming at in establishing such an installation. On a free open shore exposed to wave action and to littoral drift the shore-line moves in and out due to wave action. There is often a seasonal fluctuation of the shore-line. In winter, or during the monsoons, at times of steep waves the shore-line will move in. During the calmer seasons the swell action will cause the beach to build up. These fluctuations vary from place to place. On the North Sea coast they will be from 10 to 20 meters. In Nigeria I recently saw fluctuations of the order of 30 to 35 meters per year, a very unstable, unreliable shoreline. If you fly over an area of coast where there is littoral drift you will see that the shoreline undulates quite a lot. As those who work in coastal geomorphology are aware, these undulations may have an amplitude of up to 100 meters or even more. Another disturbing factor is that sea level is rising. Since Roman times it has risen something of the order of 2 to 3 meters, with an accelerated rise in the last 50 years. This is something that must be taken into account in long-term planning.

In order to provide a landing area we have therefore to stabilize the shoreline in some way with the nearshore profile steep, so that boats can be brought in as far as possible without difficulty. Some protection against wave action is also required if it can be provided. Finally, we must provide a widening of the beach, for the storage of boats and other facilities.

A good landing site should therefore have a stable beach, a steep beach and a wide beach. And the site must involve a low first cost and an absolute minimum of maintenance costs.

Now to consider the kind of landing facilities that may be installed, we can learn much by studying nature. There are no coast protection measures, no harbour installations (apart from certain structural aspects) that have not been tested by nature. If we examine the coastline with the eyes of the coastal geomorphologists, we find on the shores of Italy, Spain and elsewhere in the Mediterranean, and sometimes on the North Sea coasts, headlands protruding from the shoreline and projecting a little out to sea. These form natural groynes, which accumulates material on one side, making a steeper and somewhat more exposed beach. On the downdrift side there will be more gentle profile, better protected against wave action.

This pattern can be observed everywhere in the world. I have worked on this problem some years ago on the Danish coast, where we placed small groynes, from 100 to 400 meters out from the shore, which gave us an area on the updrift side that was relatively stable and where the profile was rather steep. That is the first, primitive type of landing facility or landing jetty, whatever it may be called. Later, the technology became a little more advanced; all that the single groyne did was to accumulate sand on one side, and on the other to give a steeper profile which made it easier to land on the beach - at least when the sea was not too rough.

Another example from nature, there are many places in the world where there are offshore reefs, islands or accumulations of rock. Cornwall is an example of this type of coast, but there are many other places where we find these offshore islands and reefs making a sort of breakwater in front of the shore behind which some form of landing can be provided. In order to compare various types of installation we can construct something perpendicular to the shore, something parallel to the shore and a combination of these, with something parallel and something perpendicular to the shore - Table 1, Figs. 1 a, b and c. We can also put something on the outer end, going in both directions - Fig 1a also indicates gradings for the various types of installation, under the headings referred to above: Stability of shoreline, steepness of profile, protection from waves, width of beach and cost. There are of course several other factors that must be considered in planning a facility, in addition to its layout. Structural stability is important, since whatever is erected in the sea must not be destroyed by the first bad storm, which has frequently happened. The operational aspects of the installation must also be studied. It is of no use to build something which worsens conditions in some respects, making overall operation impossible. One must be sure that the installation improves conditions, or at least that it conforms with certain operational requirements.

In Table 1 the best solution is given Grade A and each of the four installations shown in Figures are graded from A to D. Let us consider briefly each in turn. The first, most primitive solution - a structure perpendicular to the shoreline - accumulates material on the updrift side. It is given Grade B as a stabilizer of the shoreline; it cannot be given Grade A because on the downdrift side the shoreline will erode and will cause some problems there. As to steepness, it will produce a relatively steeper profile on the updrift side and a flatter profile on the downdrift side and so can be given only Grade B in this respect. It will give very little wave protection since the waves will come in at an angle to the shoreline of 5-10°, seldom more than 20°. It gives more space as the shoreline is built out on the updrift side, but it erodes on the other side. I have seen over a hundred examples in many parts of the world and very few provide more accumulation than is lost by erosion. Most groynes of this type cause erosion which outweighs the protection that they give and so are a very unsatisfactory way of protecting the shore - they are of course the cheapest solution.

The second solution, with breakwaters parallel to the shoreline, can be found in Italy, Spain, Massachussets and California. The very large breakwater at Santa Monica, for instance, did stabilize the shoreline, but it remained a rather unreliable shoreline because of the strong current sometimes passing inside the breakwater. I know of a number of such cases where, because the breakwater was rather long so much current was caused inside the breakwater during bad storms that accumulated material was entirely swept out. It came back again in time but as a solution it has to be considered unreliable. If the breakwater is long it gives good protection but waves do occur at either end, so that it cannot be said to give full protection. It provides some extra space but it must be given a low grade under this head because the space is not always available. As to cost, it must be given a lower grade than the perpendicular groyne.

The third - a shore-parallel breakwater at the outer end of a breakwater perpendicular to the shoreline - this does produce an accumulation on the updrift side and also an area on the downdrift side where there is a steeper profile. This is due to a change in the character of the waves. Very steep waves, which may be called winter or monsoon waves, erode the beach because they push materials from the bottom towards the shore. A landing area is thus created which also has a wider beach on the downdrift side caused by the shore-parallel breakwater. (There may be some problems caused by accumulation of material, which I will return to later).

The fourth - the T-groyne - obtains the effect of change in the character of the waves on beach stability on both sides of the breakwater. This is therefore the best solution, to which I give Grade A under all headings except economy, since it is the most expensive one. In thus describing layouts you may ask "do they work or not?". A precise answer is not possible in any particular case, since such structures have to be placed correctly and

must have the right dimensions. We must not build something in 1975, only to find in 1977 that it has become a small-scale Ostia, completely buried by sand. On an eroding shore this does not occur so readily, but it may easily happen that where sand is migrating in large quantities it will build up - for example in the case of the third alternative layout - to such an extent that it reaches the extreme outer end of the breakwater and comes down on the other side towards the shore. It is therefore important that we should know something about the quantity of drifting material and also about the profile configuration of the shore. Planning based on experienced is necessary and once again the answers are often obtained by going back to nature. I am a very strong believer in such models in nature in a scale of 1 to 1. The more one studies these, the better one is equipped to deal with problems.

It is not necessary to build a complete installation - at the beginning it can be a step-by-step procedure. It is very important to get the dimensions right at this stage; this means that field data is required - on profile, on drift and usually on waves. This means that wave statistics from extreme storms are essential, which raises a very important operational question - where should the structure be placed? If part of the structure is parallel to the shore, that part should be located outside the first breaker-line. If it is placed inside the first line of breakers boats have to pass through these breakers to reach the shore, and so little is gained, although something might, however, be gained if the structure gives better landing conditions on the beach.

Along the shorelines of India, a number of cases of heavy wave-action during the monsoon have been studied. It was very clear to us that in order to evaluate the problem we needed wave data, and this was very difficult to obtain. On one project being investigated we despaired of getting data. We erected a wave pole out at sea and made a great many detailed observations over one year - waves outside and inside the breaker zone, and their direction of approach. In this way we got data which enabled us to compute the quantity of littoral drift. I do not know how accurate this was, but it was of the right order of magnitude. This then was a place where we had to make an urgent study of the phenomena. I do not say that this has to be done everywhere in this way, but I do advocate very strongly that in order to plan some facility you must have an input of data; data for the design and for operation. For design purposes one year's data may be sufficient, during which you may hope to record some bad storms. In some areas of the world - on the Gold Coast and in most parts of India, for instance, the wave action is so uniform that one year's records almost amount to long-term statistics. This is not true of the North Sea, however, where it is necessary to design on entirely different concepts based on long-term statistics. In planning it is essential to know how frequently the installation can be used, and under what conditions it can and cannot be used, and for how long each condition will last. This is an area in which studies are being carried out at present by the PIANC Wave Committee - members of which Committee are here present. In this Committee, and in the Committee for Reception of Large Vessels, we are working out procedures so that we can plan these facilities and know in advance how effective they will be. I might add there is no difference between large and small vessels when wave statistics are involved. This information, in turn, relates to the economy of the entire installation, since you cannot operate a facility unless you know that it cannot be used for so many hours a day, or so many days in the month - it is absolutely vital to know how often you cannot operate. In a Report which I shall place on the table, we have developed certain statistical models for estimating storm durations. This is a Norwegian contribution, but it might be hoped that others would contribute the data they collect.

I have been discussing long, uninterrupted shores, where you need information on waves, currents and the quantity of drift, so that you can arrive at a sensible design. Not all coasts are uninterrupted; many have gaps through barriers, connecting the ocean with lagoons or bays inside - what we call tidal inlets. As to bringing boats across the beach, I will refer you to a famous Greek who lived over 2 000 years ago - Archimedes. He may not have discovered buoyancy but he did explain it. I will only point out that the easiest way to cross a beach is to float, and so the tidal inlet is one way of crossing a beach. Some tidal inlets are openings in a barrier of sand, on an open shore, with a lot of drift material coming in, usually from both sides. We also find estuaries - rivers carrying silt

and perhaps some sand. I want to stress very strongly that the tidal inlet on a shore subject to littoral drift and the estuary are two quite different "animals" with quite different habits. It is therefore very important not to classify an estuary as a tidal inlet, or vice versa. They may occur together, but usually they can be classified as one or the other. In my book "Tidal Inlets and Littoral Drift" (Reference No. 3) I quote **actual examples of difficulties and the solution of problems, these are now referred to by page and figure number.** Remember that we are still thinking of small-boat operations, i.e., **boats of modest size** and this is important when we are evaluating a tidal inlet. A tidal inlet on a drift shore cannot stay open unless it has a certain minimum cross-sectional area, which means a certain minimum discharge flow; without this it cannot survive. All over the world on many occasions, engineers seeing a lake close to the coast have said - "here is a lake; let us connect it to the sea and we will have a good harbour free of charge. All we need is to make an entrance." I have seen this many times, and it does not work. Nature closes the entrance very quickly because there is not sufficient flow to cope with the natural littoral drift. On page 4 of the book you will see a barrier beach; the cross-section is shown in **Fig. 1. This also shows how the drift is distributed. The drift is strong close to the shore, fading out offshore. There is an off**shore drift between 20 feet and 40 feet - it all depends upon wave-action - but one can be sure that most of the drift occurs between a few meters above sea-level and up to perhaps 5-6 feet to 20 feet or so. A hole can be punched in that bar, by a monsoon or a hurricane, or by somebody determined to open up something, who believed that there was enough water inside to meet his needs and those of a few others. Very soon he would have a wild animal to control. **The Frontispiece(Reference No.3) also shows an illustration of Redfish Pass, in** Lee country, Florida. A few Indians lived there until the white man moved in quite recently. The newcomers made a hole through the barrier. The book shows the result - a tremendous rush of water, throwing up millions of cubic yards of material on either side and cutting a channel 9-12 meters deep where the depth had only recently been 1 meter. The shore was heavily eroded on either side. So one has to know what one is doing and to be very careful when doing it. On page 6, Fig. 3 (Reference No. 3) there is a demonstration of what can happen to a shore. Where such a tidal inlet passes through, a bar usually develops outside and some shoals form in the bay. On the North Sea coast of Holland and England, in the Bay of Bengal, the Arabian Sea, in South America - exactly the same situations are found. As a result a boat can pass through, but it has to pass over a relatively shallow bar, perhaps 1-3 meters deep, and when there are waves they break on the bar. The bar also acts as a bridge for drift, carrying material across the entrance, and this means that erosion of the downdrift barrier is limited, simply by the presence of the bar.

What happens if we try to improve such an inlet? An actual case, shown on page 21, (Reference No. 3), the Matanzas Inlet, on the Atlantic coast of Florida, is an entrance where a small boat can be kept, if you are prepared to pass through the breaking waves on the bar. So far, nothing has been done to improve this entrance because it is too wide, while drift of approximately 400-500 thousand cubic meters a year would make it very difficult to handle. Any projecting structure would have a very serious effect on the downdrift side. There is another example on page 23, Ponce Leone Inlet, also in Florida - which has been a testing ground for much work in which I have been involved. This is a very large inlet, just south of Daytona Beach - a very wide beach. A very large body of water pours through, maintaining some channels. These channels are very wide and they migrate up and down the coast, but the people there have been able to establish a small boat fishery, with boats **up to 20 meters.** This has been made possible only by the continual surveys done by the US Coastguard, which locate the channel. If the channel is found to have moved after a storm, they simply move the markers. This system has worked at a cost to the Government, but naturally the fishermen would like to have more stable conditions, and recently breakwaters have been built on each side of the entrance to try to provide the stability.

At a place further north called Fort Pierce (page 26, Fig.11, Reference No. 3) they wished to create a somewhat larger port installation and they therefore built parallel jetties, that on the north side longer than the one on the south side. In this case, the drift comes from the north. Some sand is deposited, which is carried out again by the ebb currents. Because one jetty is longer than the other the sand escapes downdrift, and the waves carry

it back to the shore, which is quite satisfactory. A fishery is based there now.

At Sebastian Inlet, not very far from Cape Kennedy, there is a very large body of water inside, into which an artificial inlet was cut, and relatively small and inexpensive jetties were built. Material is brought in by the flood current, passing between the jetties to be captured by a trap - a large hole dredged inside. Most material brought in settles in this trap, from which it is pumped from time to time to the opposite downdrift side by a conventional hydraulic dredge. The whole system was investigated by model studies. This transfer arrangement has to be paid for of course, but large fisheries, both pleasure and commercial, are located there. The system works satisfactorily because there is ample flow. It was necessary to build relatively inexpensive jetties only because of the character of the shore.

On page 45 (Reference No. 3) you will see South Lake Worth Inlet, 20 km south of Palm Beach. This was the first place where an artificial entrance was made from the ocean to the bay. This was done in order to deal with pollution. The large population of Palm Beach were polluting the water in a number of ways and it was necessary to create some circulation. The cutting of the entrance had therefore nothing to do with fisheries, but today there is considerable fishing activity, although the entrance is too narrow, not more than 30-40 m wide, a rather dangerous channel to pass through. A permanent by-passing system has now been installed; pages 50 and 57, Figs. 17 and 18 (Reference No. 3) show the inlet, the movement of drift, erosion caused by this and the by-passing plant - a dredger on the updrift side digging a deep hole and pumping the sand across to the downdrift side. This arrangement has functioned well and the amount of bypassed material is only 70 000 cubic yards (50 000 cubic meters) a year. This is a relatively inexpensive structure and the ebb current flushes out accumulated material.

We hope that some installations we have designed for FAO in India. at Malpe. will be maintenance-free. The drift is small there, and there appears to be enough flow to clean out the entrance, while the jetties are in relatively shallow water. However, this is a medium-, not small-scale fishery. There are places where relatively low cost installations can be made. I would refer you to an article in the Dock Harbour Authority of July 1974, containing a complete review of all the different types of by-passing procedures in operation.

One has to be rather careful in distinguishing between developing and developed countries. I was surprised to find in India, on the south-east coast, a very interesting jetty which had been developed, which operates on the to-be-or-not-to-be principle. It can be simply a trestle or, by adding vertical sheet-piles or slabs, it becomes a jetty. During part of the year it will be impossible to keep it as a jetty but for the rest of the year the sheeting can remain in place. Drift accumulates against it and if it becomes too much the jetty can be opened up to let the material pass through. A by-passing plant can also be put on the structure. This is something that is operating, a new contribution to small-scale operations and a very good idea.

It is very important that we should know the boundary conditions before we start designing something. In dealing with shore problems in many parts of the world, and with people from many of the Departments of Fisheries and of Public Works, I have found that they have in common a failure to appreciate how necessary it is to secure data.

The United States is a land of highly-developed technology; the US Army Corps of Engineers has made most important progress in handling problems of development on the seashore. Their methods are different from those used in Holland. The Dutch have perhaps 2 000 years of experience. The first text-book on coastal engineering was written about 400 years ago by Andries Virlingh. His philosophy was as follows: "You shall not put anything out in the ocean by which you interfere with the natural regimen, because if you do that, nature will turn her forces against you." You will see this philosophy demonstrated everywhere in Holland - "Be streamlined." And almost everything in Holland is static; they are defending themselves against a very large, powerful enemy.

In the US it is different; everything is dynamic, moving. They have to deal with very strong littoral drift and so everything connected with drift is more developed than anywhere else. Ponce Leone Inlet was developed by the US Corps of Engineers on the theory that the drift was predominantly southwards. After the project had been completed it was realized that this was not true - the material accumulated on the other side. I am afraid that what is said about Ponce Leone in my book, which was written mainly in Florida, is not always correct. The information came from the US Army's scientific corps. When they saw what was happening they began to make wave observations and computing the drift; had this been done earlier the design would have been different. This, I am glad to say, was the only inlet in Florida for which model tests were not made in the University of Florida. It was not a widely-published mistake and we should be understanding about it. Harbours present problems also. On page 66 (Reference No. 3) is shown the Hirtshals Harbour, Denmark, where the drift is more than half-a-million cubic meters a year. Two breakwaters were built. Very soon there will be 8 meters of water in the entrance, where once it was possible to walk across with dry feet.

Fishing ports are being planned for Nigeria and there is talk of establishing tidal inlet bases on a shore where there is a lake or lagoon of modest size inside. This is a place where there may be up to 600 000 cubic meters of drift alongshore, and if a modest-sized entrance is formed here it cannot last more than a few weeks. Wherever there seem to be possibilities of establishing a tidal inlet base, for example in the Arabian Sea, the Bay of Bengal, in Ecuador, Nicaragua, etc., the same situation constantly arises. There is a large lagoon and the people would like to use it as a harbour. There may be a small, narrow connecting channel which is open for part of the year. So they plan a small-scale harbour for boats of 5, 10 or perhaps 15 tons and they apply for funds. Now there are certain very important boundary conditions that must be fulfilled. In the first place, in order to keep this entrance open a lot of total effort is needed. But there has to be a certain balance between the amount of water passing through the channel and the quantity of sand coming to the entrance on the sea-shore. If one studies entrances in all parts of the world one finds that the same laws apply. Stable entrances, which have been in existence for many years, have certain features in common. The mean maximum velocities recorded during spring tides are all of the order of 1 meter per second, $\pm$ perhaps 15 cm. This fact can be explained by the development of bottom friction; the bottom configuration changes as the velocity approaches 1 m per second, from ripple-marks to much longer sand waves to a completely smooth (Reference 3, Fig.32). In addition to this condition it is necessary that there should be a certain ratio between the volume of the Tidal Prism - that is, the total amount of water passing in and out of the entrance in a tidal cycle - and the total quantity of drift material per year to be removed. This ratio, which is a dimensionless figure (both quantities are in cubic meters) should not be less than 100. If it is less than 100 the entrance will not be cleaned and a bar will form in front. There are many places with a ratio of less than 100 - most of the entrances in India and many other places throughout the world. In these cases large bars form outside and small boats have to pass through the surf. If the ratio is about 150, as in the case of Thyboron Channel, this is relatively satisfactory. A really good entrance will be over 150, up to 200-250 or even 300, and in Holland the ratio may be several thousand. Some of these entrances are still being closed, so it is important to note that the ratio must be fulfilled for all seasons. It is not sufficient to achieve an average for the year, or to exceed it in December if it is not fulfilled in June and July. Thanks to a great deal of work done in many places, particularly in India, we know much more about the sensitivity of this ratio. In a paper for the Proceedings of the Coastal Engineering Conference in Copenhagen 1974 (Reference No. 11) a great deal of US, Dutch, Danish and other European data has been studied and compared with the Indian data, which compares well with the rest.

We are now able to classify harbours in much greater detail and so, just as structural engineers speak of safety factors, ultimate strength and allowable strength, we should be able, as engineers, to introduce and maintain principles of that kind, no longer working by rule of thumb or by appearance, but by putting in all the figures and computing the design. The computing of littoral drift is still very difficult, but we are gaining more and more experience. We can compute the hydraulics of the problem quite accurately, which

means that we can design an entrance. Then by rather elaborate tidal computations, we can design an entrance. Then by rather elaborate tidal computations we can get the correct figures for the tidal prism. I show a table (Table 21, page 124), for use in designing a tidal entrance, to determine if it is economical. The abcissa, M, is the total quantity of drift coming through the entrance in a year from either side of the channel. The ordinate, A, is the cross-sectional area of the entrance in square meters. Using the velocity of 1 meter per second this makes A the volume in cubic meters per second. Then by a relatively simple tidal calculation the total flow can be obtained. The volume can be calculated from the discharge, and vice versa. To take an actual case, with a modest value for the drift, M, 100 000 cubic meters per year! From the table we read that this is a poor installation if the cross section is ≤ 500 m^2. Taking something between a fair and a good installation we note a figure of .0067, and moving horizontally from this gives a cross-sectional area of 1 000 sq. meters, that is a flow of 1 000 cu.meters per second. This is the flow required and from this the required tidal volume is computed. This is rather involved to describe here; I would refer you to Dr. Dronker's book "Tidal Hydraulics" printed in Holland (Elsevier). Knowing the tidal volume required you must look at the possibilities; are there marshes of sufficient capacity? You must then obtain the difference in tidal range between the ocean and the lagoon. In this way a fair picture of actual conditions is obtained. This process is based on a great deal of information which has been available for more than ten years. Since then considerable experience has been gained.

We are thus approaching a stage when it will be possible to design without using model studies, in the same way that a bridge or a highway is designed, and to get reliable results. Model studies will still help in refining entrance conditions, or in studying by-passing problems, but these are details. There are now several cases designed on these principles, which have achieved a no-maintenance condition, at a relatively low cost for jetties. These are working well. So, for small-scale fisheries, for boats with a draft of 1, 2 or even as much as 3 meters, you will arrive at the conclusion that you can afford the development, because maintenance will be insignificant and the necessary jetties can be short, particularly if discharge from inside the lagoon is adequate, and if there is not enough you can increase the quantity and also create new areas of land by dredging and filling. This has been done in a number of places where, by dredging and filling, a larger water area and additional waterfront is provided, which can be used for all kinds of industries, for homes and other developments. You have thus created a water space - a lake, canal, etc. - and a good recreational area, with a safe beach, an improved area where land is now at a greatly appreciated value; and you have got a larger tidal prism at no cost. This is certainly something that should be considered, at least where the ground is fairly low; there are, of course, places where high ground exists and too much excavation would be needed to provide the necessary facilities.

We are therefore approaching a situation where something can be done for relatively small-scale fisheries - such places as Neendakhara and Malpe in India - which will not shock the economists. In most of the port projects in the world, the money earned by handling goods is small in relation to the cost of building the port, or of interest on capital, etc. But as soon as you take into account all the benefits which have been gained the situation looks quite different. And it is a chain process; a port creates many industries, many jobs. All this can be quantified and in the US marine projects are evaluated in this way. If you wish to have a project accepted by Congress it is very wise to show a benefit/cost ratio greater than 1. For instance, we can say that taking a swim will improve health by $ 1. Then all that is necessary is to put 100 000 people on the beach every year, taking a swim, to arrive at a benefit of $ 100 000. It is not suggested that we should follow this example, but there is scope for imagination, particularly by bankers.

Summing up, then, we have difficult coasts; uninterrupted coasts with littoral drift and coasts punctured by inlets, estuaries. It would take too long to deal in part with estuaries - they are very complicated, raising the worst range of problems in sea-coast hydraulic engineering. Most estuaries have channels which remain relatively free of deposits - flood channels, ebb channels and neutral channels. There will in fact always be a channel in an estuarine river, but it will not be stable and it will be necessary to

control it by building training-walls, as in the river Mersey in England or the Karnafuli in Chittagong. All rivers which are to be improved have to be trained. This is mainly done to serve general commercial traffic with larger vessels, where fishery vessels have to fit in. There are of course places where a fishing port can be placed in a good channel that is being used by nobody else. Therefore, good long-term surveys are essential, to locate the good channels. There are also places blessed by the fact that littoral drift caused naturally is diverted from the entrance; needless to say, such places are particularly attractive. One must constantly use one's eyes in looking out for the best places; then do some calculations, collect the necessary data, evaluate the possibilities, ask ourselves if the project is technically feasible, and arrive at figures for initial cost and for maintenance. Maintenance dredging is a great problem, especially in developing countries, and so the more that it can be avoided the better - for example by natural flushing. And be sure that you understand how nature will behave, and then by every means try to stay in control of the project from beginning to end. Do not leave anything to chance; know exactly what you are doing and plan for the next 50, or the next 100 years.

Finally before I complete this talk, there is one possible approach, perhaps more common with commercial piers, of which there are examples in the Gulf of Mexico. A trestle is erected in the open sea, to be used simply for berthing purposes. This is feasible for large vessels, or even for fishing boats where there is a pronounced seasonal variation in wave action. If there is a period of the year with very little swell a boat can operate at such times from simple trestle pier. A Tee-head can be added to provide some protection, but this would have to stand up to broadside wave action at other times of the year, when it is not such a good idea. A crane can of course be put on such a seasonal jetty, either a gantry-crane or a normal derrick, removing them and the boats when they would be exposed to heavy swell.

Questions

On the termination of this talk by Professor Bruun, the Chairman expressed his sincere thanks for such an all-embracing and most illuminating treatise on coastal engineering problems. He then, with Professor Bruun's agreement, requested questions from the participants present.

In answer to a number of questions from Messrs Bhakta (India), Cabezas (Peru), Moor (Netherlands and Peru), Wong Kim Yok (Malaysia) and Godri and Guckian (FAO), Professor Bruun gave the following additional information:

Professor Bruun:

(i) Re availability of data for design of installations, and necessity for adequate instrumentation and survey equipment. In Norway there have been enormous developments over the past 5-6 years, because of North Sea activities. There was a great need for instrumentation - at present, for example, they have 12-14 wave-riders and have set up an Instrument Bank or pool, stocked from whatever was available from one or other of the large oceanographic laboratories. Their National Science Foundation also put up a lot of instrumentation. Instruments could be borrowed at short notice from this pool.

(ii) Arriving at a value M for the total quantity of drift material. Arriving at the quantity M is a problem. Something is known from the accumulation of material on the updrift side of entrances, and in Dutch canals, where they know from many years experience the order of magnitude of material passing. Otherwise, if you have very little information you can try to compute it, by methods which have been developed. The US Corps of Engineers have done pioneer work. I should also mention other work in France, and in Holland. Normally I use the US method with which I am familiar, but it does need a lot of detailed information about wave action. If you do not have this information from actual data, it is necessary to do some hind-casting of waves. This is a procedure that requires some special knowledge, but there are people with this experience in many parts of the world, who are able to hind-cast by various methods. I would never use a Dutch formula

alone, or a US formula or a French formula alone. I would use all three and note how much they varied, and try to determine which was the best. But the US Army formula is reasonably reliable, because the Corps of Engineers have gradually built up this technique of hind-casting which they first developed for the invasion of Normandy. I should also mention the method of Svasik in Holland. He has developed a modification of the US method which in many ways is easy to use. We used the US-Svasek method in India, and got a rather higher result than we expected. But it is better to have too high a figure; you have to play safe. Another method is by tracing. Dr. de Vries, who has recently been appointed professor at the Delft Technological Institute, has written a most comprehensive thesis on tracing. De Vries indicates three methods; the increment method, the continuous injection method and the diffusion method, which has been highly developed by him. The Wallingford Hydraulics Research Station in the UK has also done a lot of work on the subject. Objection will be made that tracing requires a large input of material, and that it cannot be used in heavy surf. I used the technique in Nicaragua within the last few years and while it is true that some tons of material are needed, it costs very little. The only problem that I met was in passing the material through customs, because they suspected that it was some other material. The technology is fairly simple though a mass of statistics is necessary. For the development of Kingston Harbour, in Jamaica, for instance, tracers were used over a very large area - more than 20 square miles. Silt tracing is easy, using the waste product from factories producing tracers. Tracers are produced in England and in Florida.

In this way it is possible to determine M within a certain variance. These devices are easy to use and can be used for other purposes. But one must remember that nature varies a great deal, in changing weather conditions, and so it is better to play safe. However, we gain knowledge every day in this field in tests to a scale of one to one.

(iii) <u>Measurement of drift from dredging results and photography.</u> It is possible to measure the accumulation and the erosion by this means. Recently I had to check some data on material that had been accumulated on the updrift side and some data on dredging. I computed the erosion, including the rise in the sea-level, and got figures from 600 000 to 800 000 cubic meters per year. This can be done if there are installations of that kind on the shore. If not, you have to use one of the methods of tracing described by Dr. de Vries, or straight computation. Personally, if I were in a hurry and did not have any wave data, I would use hind-casting - there are people in England and in Holland who can do this. In this way you will get figures for the order of magnitude - but do not forget the large variance that occurs in nature.

(iv) <u>Construction of a landing pier in a sickle-shaped bay with littoral drift, as in a number of cases in Honduras.</u> As in the case of Honduras, the strong drift is a problem. The easiest course is to leave the structure open and extend it out to the depth that is required, letting the drift pass through. With modern pre-stressed and post-tensioned designs things are better than in the past since piles can be spaced well apart. But if wave protection is wanted, then there is a problem; you can be sure that material will accumulate in the places where it cannot be tolerated.

(v) <u>A case of Malpe in India, where the entrance is moving laterally with the monsoon seasons.</u> As in Malpe, tidal entrances are usually moving. There is a barrier which is broken through, the drift goes northwards and the entrance therefore moves. If there are islands outside, as in the case of Malpe, the waves are diffracted and refracted and finally come to a certain place, where the entrance becomes stabilised, within a range of, say, plus or minus 200-300 meters. It happens at Malpe that there is a lagoon inside, and the maximum river flow is about 400 cubic meters per second; drift is not more than 100 000 cubic meters per year. Occasionally, after heavy rain and floods the river breaks through the

barrier directly, at a point where it had broken through before. But then, it works its way back very rapidly to its old stable outlet. The depth contours outside, to 3 or 4 meters depth, are the same as before. So it is a quite local disturbance, and the river rapidly returns to its old configuration.

It is always best to form an entrance where the direction of propagation of the incoming waves is parallel to whatever structure is built. In this way one avoids as far as possible material passing round the tip of the structure. If the entrance is made at an incorrect location the drift will still be there, and the port will not survive much longer. I will refer to four points in the FAO/UNDP Project Report (Reference No. 18). On page 12: "Relocation of the entrance, turning it anticlockwise, to the position of the present breakthrough channel, would have the following drawbacks as compared with the location originally proposed:

(a) Rapid shoaling due to lack of storage space for material on the updrift side.

(b) A more dangerous wave situation, due to the crossing of waves coming in from various directions, which was observed during the monsoon period. We once had a personal experience of this when the boat we were in, with ten men, was completely turned over

(c) Concentration of currents on one side of the channel will undoubtedly cause erosion, as well as some accretion problems which would become troublesome to the whole installation. (One can take action to prevent the planned harbour being undercut. Basically, the rule is - be streamlined; avoid large curves and entries, follow the example of the Dutch canals wherever possible).

(d) The proposed operation facilities would have a somewhat awkward location and more protective walls would have to be built to shield the harbour basin from the ocean. This means that the proposed installation would have to be moved up river and this would create depth problems. If the installation is kept where it is, that is as nature intends. Waves will come in perpendicular to the entrance training jetties. The jetties can easily be made longer or shorter as required - I always prefer to make them a little longer than actually needed; the equipment is there, so why not use it? Wave action will be less, and the entrance will be better in all respects. If you are afraid of the amount of material that will come around the end a spur can be built a short distance from the extreme end of the jetty, which will catch some of the sand as it comes round. The layout also provides the best approach-line from the navigational point of view. I would therefore prefer to turn the entrance a few degrees clockwise from the position proposed."

SESSION II

Design of Special Vessels, Gears and Equipment for Use in Difficult Coast Conditions: Introduced by Mr. E.W.H. Gifford

Mr. E.W.H. Gifford

As the Chairman has intimated, I am a civil engineer and it may seem strange that I am doing this kind of work. It arose out of my harbour interests and my wife's career as a geomorphologist, and from the FAO International Conference on Fishery Harbours at Bremen in 1968, where a number of the delegates said firmly that what they wanted was not so much formal harbours in convenient rivers but an improvement of the situation on surf beaches; providing for open beaches rather than searching in vain for a suitable place and moving people to that location. Now from what has been said in the previous Session by Professor Bruun, the problem of open beaches is obviously a very difficult one. After hearing Professor Bruun I feel even more nervous than I did at the Bremen about doing anything to improve a completely open beach. It seemed to us then that perhaps in certain circumstances the best thing to do would be to improve the boat and leave the beach alone. Obviously there are many circumstances where that is not the right thing to do, but there are places

where I think it is the right solution.

Some people have asked for guidance as to what is the best solution. There is of course no best solution; there are normally many solutions, almost as many as there are individual sites. So what I am proposing is really only the beginning, as it were, of a particular approach. I am certainly not competent to suggest that it is the final answer, covering all fishing boats on all open beaches. That would be ridiculous. It is a solution which works in, and is suitable for, a certain area which could, we think, be applied in its present form to certain other areas, and in extensively modified forms to other places.

[Mr. Gifford then illustrated his talk by showing a number of slides of various kinds of beaching vessels - the Irish curragh, the Yorkshire coble, the Hastings beach boat, the large flat-bottomed Portuguese beach vessel and a number of African and other kinds of canoes.]

The characteristics of the surf in the tropical countries in which we are mainly interested are quite different from the surf in European countries. The constant surf in tropical countries is generally higher than in European countries. The maximum tropical surf, in storm conditions - except of course in hurricane zones - is, however, generally less severe, sometimes a great deal less severe, than occurs in European countries.

We have therefore to look for a boat which can go through the surf on these beaches, which are generally sandy and flat; in fact, very similar to those used by the Yorkshire coble.

What we have aimed at is not a substitute for the canoe. That is another problem for which there are a number of good solutions, for which ours is not intended as a rival. Our sole purpose is to develop a boat, capable of working through these conditions and with moderate fishing capability, which can handle several tons of fish and gear, can carry ice, can trawl, can carry a seine net and so on.

Having studied this problem it seemed clear that it was of great importance that the boat should not be hit by the seas when on the bottom; in other words - shallow draft was important. If a boat can go in, like a rubber raft, offering no resistance whatever to the sea, then it may be of little use as a boat but it is unlikely to be damaged by the surf. So the shallower the boat, the less impact there will be when it touches the bottom. A second important consideration is that the boat should have great stability in the surf, so that if a mistake is made when coming in and the boat broaches, as is very likely to happen at some time, then the boat does not capsize. The third requirement, which is the most important of all, is that the boat should be an efficient fishing vessel, because its passage through the surf is only incidental to its real purpose, which is to catch fish.

With these criteria in mind the twin hull concept seemed worth considering. This is by no means an original idea. It was reassuring that it is possible to construct a multi-hull boat with quite simple and primitive connections that could evidently last for a reasonable time. Admittedly the lashings require replacement from time to time but these boats do hold together. I felt that, since I am a structural engineer, it should be possible to design a larger and more powerful twin-hull boat that would hold together. This in effect has been done, in the seven years since the Bremen Conference, first with a small-scale model. However, as Professor Bruun has said, there is no substitute for a full-scale model, and so eventually we built a full-size twin-hull boat. The drawing shows the main dimensions of this boat (see Annex IVd, Drawing 818.50). The familiar name in Europe for such a craft is Catamaran, but it should be referred to as a twin-hull or multi-hull vessel. The two hulls are simply of very slender dory form. They are connected by cross-beams at the forward water-tight bulkhead and at the transom. There is a further water-tight bulkhead amidships.

The design was not a very difficult problem. The structure is susceptible to analysis, the only unknown factor being precise loading. It was assumed that the loading would not be greater than with a fully-laden vessel supported on diagonally opposite corners. We calculated what the stresses would be with this loading and we then put strain-gauges on the

front beams of the first boat constructed and took this around Southampton Water, through the bow-waves of container ships - which produce a nastier bow-wave than liners. This caused some apprehension among the skippers of the container ships since we steered as close as possible to them in order to produce the maximum effect, the boat being thrown up high in the air and coming down on the other side of the wave. The stresses produced were not in fact as high as those calculated on the assumption that the fully-loaded boat was supported, on dry land, on opposite corners. It seemed therefore that the analysis was generally correct.

Clearly, since this is a new type of boat, the details of how the parts are connected together are also new. It may be possible to improve the details of these connections with more experience. It is not claimed that we have completely overcome the problem. So far we have had no trouble, but after three or four years in use it may be found that certain improvements are necessary. The design is quite straightforward, with the two engines fitted, one in each hull. Originally, having seen how very easily the small Portuguese boats (and indeed the much larger ones also) could be handled on the beach on rollers, because of their completely smooth bottoms with no projections of any kind, we considered putting the propellors in a tunnel. The first half-size model was in fact made with such a tunnel, but we were very surprised by the serious loss of power. A full tunnel absorbs perhaps 50 % of the available power. This is overcome in lifeboats and the like by installing twice as much power as is required but this would not appeal to a fisherman. We therefore decided that, since we required maximum power from the smallest possible installed horse-power, we should use a conventional propeller installation. This requires that the boat must land bow first and depart stern first. As to the layout of the boat, there is an offset wheelhouse, with a centrally-placed winch, thus the whole of the deck space is available for fishing gear. In the form shown the boat is rigged for trawling but a great deal of space remains available for nets of various other kinds, including quite a large seine net. It was found that gill nets handled very successfully, with men placed in each side of the bow, shooting the net over the bow while the skipper handled the vessel. Some practice is necessary to achieve coordination between the fishermen and the helmsman, but after some initial problems have been overcome, the operation goes very well. In short, as a fishing boat we are very pleased with it. We must now consider its handling in surf.

Originally, when approaching a shore, we dropped a kedge, which was a 30 lb Danforth anchor, and streamed a warp as we went in. This was done because on the first trials in Nigeria we had no shore base and were therefore coming from a harbour, landing on a beach and leaving it again - that is, the normal beach operation in reverse. We therefore dropped the kedge and warp, ran up the beach and later hauled off.

On the first run in we had the same experience as with the half-size model. The first indication that the boat is actually on the beach was when one looked over the side and saw the swash dropping away from the beach. There was no feeling of impact. Mistakes were sometimes made, but generally the boat ran straight in, arriving on the beach with no strain or trouble at all.

We continued to use this warp for a time, believing that it was necessary to keep the boat straight and prevent broaching while the bridle required to haul the boat out of the water was being fixed, but further experience showed that this was an unnecessary precaution as the twin-hull boat sits on a firm base on the shore. There is virtually no tendency to broach, but if the shore party takes a long time to fix the bridle - more than 20 minutes which is a long time - so that the boat starts to work round, it is only necessary to kick hard with one engine as the swash comes up under the stern, to bring the boat straight again. We can therefore dispense with the warp and kedge. As for the remainder of procedure for hauling out, all that is required is to put down skids in the swash - greased wooden skids, one under each hull, held at their correct spacing by 1-inch diameter reinforcing bars. A man at one end of each skid holds it in place with a rope and when the winch starts to pull the skids are dragged down into the swash, under the nose of each hull, which rides up over the skid. Once the boat is bearing on the skids it is a simple matter to put individual skids under each hull as the boat comes up.

The boat weighs about 6 tons empty and carries 6 to 9 tons of fish. Under test conditions, landing with a total weight of about 7 tons the maximum force needed to haul the boat up the beach was 2 tons, and to haul it down for launching about 1 ton. As far as we can judge the hauling forces would be in direct proportion to the total weight of the boat; if the weight is doubled it is reasonable to expect that the hauling forces will be doubled also. The forces are therefore quite small. Nevertheless, we are proposing a simple winch, run by a small diesel engine - probably a one- or two-cylinder version of the engines that are used in the boat itself. The windlass would be hand-driven, with motive power added to it, so that in the event of failure of the engine the basic hand-crank device would be available to haul up the boat. A hand-cranked windlass which will pull 2 or 3 tons is of course quite common; such winches are used on transport lorries and low-loaders. In fact the forces are such that the boat's own trawling winch could be used, with a double-purchase block and tackle, but this would be very tedious because of the stretch in the rope, and it would be awkward. In an emergency, however, one could use a four-part tackle with ten men to get the boat up the beach. The winch problem is not a serious one therefore, provided the skids are right and there is a good keel-band under each hull. After the boat has been idle for some time the keel-bands will be rusty, but once there have been a few launchings, with the skids greased and the bands well-polished, and the boat going out and in every day, then the hauling forces fall even more.

As for launching, there are many different ways of doing this, depending upon the slope of the beach. With beaches of 1 in 8 or steeper, the boat can be launched by gravity. There are many beaches where the upper berm of the beach, the swash area, is at about this slope, where it is possible simply to release the bridle at the bow of the boat, which then slides down the beach into the sea; the engines are then put astern and the boat moves off. Many beaches, however, are not as steep as this, or have a long flat area in the lower zone of the beach - that in fact is characteristic of sand beaches. Unless the fishermen are willing to wait for high tide to launch it is necessary to be able to deal with slopes of less than 1 in 8, and to do this we use a heavy anchor and outhaul. In the last trials we used a 600 lb anchor of a similar pattern to the Danforth. This was tested up to a load of 6 tons direct pull, immediately after its installation. After it had been down for a few days it would doubtless have been able to take a great deal more, but it was not tested again. From the anchor we ran a long piece of heavy chain - very heavy chain because it will be down for a long time. Attached to the chain is a snatch-block or a permanent block - the choice depends on how the tackle is rigged further up. This block is located where it can just be reached at the lowest tide, in the swash where a couple of men can go down at the lowest tide and pick it up, so that the outhaul rope can be changed and the block changed or serviced. If I am asked about the wear on the block, I must answer that it is too soon to say; the gear was not been in use for long enough. However, when one considers that this block, the outhaul cable and the oak skids are the only consumable items and that the cable can in any case be second-hand crane rope, of which there is usually a great deal available around the world, it can be seen that the cost of maintenance should be very small. Clearly, standard blocks would not be used, but special blocks of stainless steel with nylon bearings, which I would expect to last for one or two seasons without renewal.

In the actual process of launching, the cable runs through the snatch-block and back up the beach to a large hook which lies underneath the boat between the two hulls, strongly anchored through the deck. The boat is then simply winched down into the swash. As soon as the sea comes up to the boat, reverse gear is engaged and the boat hauls itself off, the outhall cable dropping off the hook as the boat passes over the block. The operation cannot be carried out at the very lowest spring tides because the block is reached before the boat actually floats, but this situation can be avoided. An ordinary fibre line is attached to the end of the outhaul cable. This is hauled up the beach to recover the cable. For simplicity the drawing (Annex IVd, Table 1) shows the winch rope running continuously down the beach and round the snatch-block. In practice the winch rope is attached to a shorter becket which goes through the block and is hitched to the bridle.

Table 2, Annex No.IVd shows a 2-boat arrangement; it can be multiplied to handle 4 or even 6 boats, depending on the distance between the winch and the edge of the sea. To haul up a boat into its own position the rope is taken around a fairlead, set in a concrete block or held by an anchor on the beach. When launching it is unnecessary to take the rope around the fairlead if the boats are hauled up in such a way as not to foul each other when being hauled down. This is not difficult to arrange.

Mr. Gifford then introduced two films:

1. Small-scale fishery operations by canoe through a moderate surf in W. Africa, showing how the canoes can frequently be swamped and crews injured or over-fatigued in the operation.

2. The operation of the twin-hulled vessel in similar conditions in W. Africa, showing stability of vessel in moderate beach swell and ease of handling by an experienced crew during landing and launching.

The Chairman thanked Mr. Gifford for his very fine presentation. The films, in particular, illustrated some of the difficulties experienced in fishery operations off the beach and gave a very clear presentation of a solution in at least one set of circumstances. He invited comments.

At this juncture, Mr. Landymore (U.K. Permanent Representative to FAO) read his prepared statement, which is transcribed fully in Annex I.

Mr. P. Gurtner, Chief, Fish Production and Marketing Service (FIIM), then presented the following statement on FAO activities in this field:

Mr. Gifford has shown us an extremely valuable solution, one of many possible solutions to the problem that we are discussing here. I would like to tell you very briefly of the direction in which FAO is progressing at the moment, because I think this will be a matter for discussion later. We are attacking the problem on similar lines to Mr. Gifford, though working on the assumption that the solution to this problem will be given by a single-hull boat. This does not mean that we do not think that Mr. Gifford's solution is a good one, but we think that a single-hull solution is also needed. I agree very much that we are dealing here with the problem, not of replacing canoes or indigenous craft, but of creating an intermediate fishing boat of about 40-50 feet, having the right amount of power to handle the gear properly, to catch a suitable volume of fish and to land it in good condition on the beach, for processing or handling as fresh fish. That is one part of the problem - to create that kind of boat. The other part of the problem, that of replacing the canoe, is much bigger. I would like to remind you of what Mr. Appleyard said yesterday - that ultimately we must ask ourselves how the fisherman benefits. The large mass of fishermen who should benefit are those at the lower end of the scale - I would not say down to the 100 dollars a year group, but perhaps to 1 000 dollars a year, which is still rather small. There, naturally, the overruling requirement for all solutions is economy. As Mr. Gifford has pointed out, it is not possible to think in terms of replacing canoes either by his twin-hull solution or by the type of boat on which we are working - the single-hull boat which may be a little cheaper than his, but not all that much. To give an idea of the problem, let us consider the beach situation, perhaps somewhere in West Africa, Senegal for example, where the traditional beach-landing canoe is known to be a very efficient fishing boat. It is somewhat different from what you have seen on Mr. Gifford's film, but it does the same job, it has about the same investment value, it gives work to about the same number of people. In most cases it catches the same type of fish, and it is a very efficient unit, contributing tremendously to the total fish catch of Senegal, which on the consumption side is probably one of the highest per capita in the world - abour 85 kg per head.

On a beach there may be found something like 200 of these canoes, being used by 4-6 people - a work force of about 1 000 to 1 200 people fishing with these boats. They represent an investment, for the boats alone, not including their gear, of approximately 100 000 to 150 000 dollars. Naturally, it would be unthinkable to give intermediate fishing vessels with 60 hp engines to these 1 200 fishermen, representing an investment value of the order of 5 m dollars. It just would not work.

So we have to attack the problem from a completely different angle, and economics will dictate how far we can go with complexities of design and material. We have calculated recently that in Senegal it would be feasible to replace these simple dug-out canoes by locally-built small flat-bottomed fibreglass craft, with a capacity of about 6 tons of fish. Because those would be used almost entirely in the pelagic fishery, catching sardines which have a rather low unit value as landed ashore, the cost of the craft cannot be more than approximately double the cost of the canoe; otherwise it would not be economically feasible. We have to build on that assumption. It so happens that we think that it is possible to build such a boat locally of fibreglass. We hope that CIDA is going to assist the Government of Senegal in developing such a solution.

You may wonder why we are thinking in terms of fibreglass. This brings me back to something that Mr. Gifford said about the cost of his boat. One of the very reasons why we agree with the Government of Senegal that a new material must be used, is the fact that timber for the construction of canoes is becoming very scarce and expensive, and with the general scarcity of timber in the world we must agree that there must be other uses for this valuable forestry resource than making dug-out canoes. So another material is needed and we think that fibreglass is useful in this context because many boats will be required to replace the existing canoes, calling for mass-production techniques, to which fibreglass lends itself. Mr. Gifford hopes that his twin-hull solution can be produced at a substantially lower cost in a developing country using timber, but I am not convinced that he is correct because of the rising cost of materials everywhere.

I think we must divide the question of economics into two parts. We have first the boat, which with fishing gear is the one essential tool of the fisherman. Whatever solution, whatever type of boat is evolved, it must in itself be economically feasible. I do not think that any fishery development in which the boat is known not to be economically self-supporting would be successful. On the other hand, I think that the infrastructure required to make the boat a success - whether in the form of jetties or breakwaters or winch systems, such as Mr. Gifford has described - need not necessarily be economically feasible in the sense that it must show a positive return on investment; that part of the investment might have to be considered as a public utility, a social investment. But I am convinced that the boat must be self-supporting. I also think that it is not usually of much use to propose solutions to the beach fishery problem that require large state grants or subsidies. Possibly small grants or subsidies, such as taking the tax off fuel or partially meeting the cost of engines, could be considered. We must try to find, in each individual case, a solution that will fit the economy of the particular country, or even the particular area of the country, the particular fishery or resource or type of product that results from that fishery.

That is not in any way a criticism of Mr. Gifford's contribution, but it is intended to indicate the thinking in FAO on these matters and the background against which we build up our efforts to provide different kinds of long-term solutions.

tions

From a number of questions and supplementary questions by Wong Kim Yok (Malaysia), Bhakta (India), and Messrs McGrath (Ireland), Delap (Ireland), Adam (OECD), Van Steenwijk (visitor), Gurtner, Fyson and Guckian (FAO), Mr. Gifford gave the following additional information:

Mr. Gifford:

(i) Order of Cost of the prototype twin-hulled vessel. The only measure of cost available at present is the United Kingdom building cost. This of course is not a true figure, because the craft is designed to be built in the developing country itself. In the UK a boat such as that described, with aluminium hulls, two 30 hp engines and the necessary equipment would be 35 000 dollars. Because building in timber in the UK is no cheaper than building in aluminium, we considered if the boat were built in the UK it might as well be a long-life craft. We believe that a boat built to a simpler specification in a country with a good supply of timber and good timber technologists would be of the order of 25 000 dollars. As to fishing capacity, we have had no satisfactory measured trials with other fishing boats. We have tried to organize trials in the UK, but in areas where there were unfortunately not many fish, and so we have no good comparison of fishing power. The boat's 60 hp engines develop nearly three-quarters of a ton of static pull, which is enough to pull a 7-fathom headrope trawl, that it has more deck capacity than the normal boat carrying a trawl of that size, that its hold capacity is equally good and that its cost is comparable, although it is slightly more expensive. It compares well enough for a number of fishermen in the UK to be interested in it as a fishing boat, irrespective of its capabilities in surf; they feel that as a fishing platform it is superior to the conventional boat of similar size and price. As to crew, a really good man could operate it single-handed, but normally four would, I think, be its crew. It could replace a large number of existing canoes, but one would hope that it would not be used in that way but rather as an addition to the existing fleets.

(ii) Experiments in launching and hauling up without putting down skids. The skids are essential only to the extent that they reduce the power required to move the boat on the beach. The Danish outhaul does not use skids, which may well have been the reason - or one reason - why it proved rather expensive. Without skids the hauling power needed is almost equal to the weight of the boat, whereas with skids this can be reduced to about 1/3 of its weight. The only disadvantage of skids is the labour required to move them about. The number of men which I gave earlier was for the boat's crew; a shore party is also necessary. The Ghana canoe shown had a crew of about twelve, but the party on shore required to haul the net which it takes in may be up to forty. One must therefore consider the whole operation. One point may be made; skids do use labour which is sometimes surplus.

(iii) It is necessary to wait for high water to launch on beach, and can the use its own machinery for these operations; what about wear on the keel It is not necessary to wait for high tide. If the beach has a very flat slope, so that it is necessary to use the outhaul, then it is convenient to install the anchor so that the block will be exposed at the lowest of spring tides for periodic inspection. In that case the boat cannot be launched at the lowest of spring tides. That is not a great disadvantage; many harbours cannot be left at the lowest tides, and fishermen are quite used to working tides. If it is really essential to leave at the lowest spring tides this can be done by moving the anchor further down the beach, using a longer chain and inspecting the block when the surf is low by lifting it between two canoes. As to landing, there is of course no restriction at any time.

The boat's machinery can be used to haul out, but it depends very much on the power installed. At present we use a light trawl winch, with a hauling capacity of about half-a-ton. That is all that is needed for trawls of the size that would be used in a boat of this power. If this small winch is to be used for hauling the boat up the beach, multipliers in the form of blocks and tackle will be necessary to give the two tons required for hauling up, and there will be a lot of rope lying about the beach. The ship's machinery could be made more powerful, but as one shore installation will handle four or more boats, I feel that it would be uneconomic to increase the size of each boat's machinery solely in order to haul it out, when one winch on the beach can deal with them all. Further, in the event of the boat's machinery being damaged no means would remain for hauling up. In short, the boat's winch can be used, but I think that on balance it is better to have the winch ashore.

The amount of wear on skids has been small. The amount of work done has also been small, but we can learn from similar situations where skids are used for beach boats; these do last for many years. We use a fairly thick keel band - 1/2 inch - and this will probably last for 8-10 years. The skids are greased and the wear is not great.

(iv) What size of propeller would be used in trawling? As to propeller size, the craft shown uses a 19" diameter propeller with 10" pitch, for a 30 hp engine on a 2:1 reduction. We could obtain more pull with this engine by using a 22-23" propeller, the static bollard pull is nearly 3/4 ton. While this is not exceptional, it is quite good, particularly in view of the shallow draft of the vessel, which draws only 2'6". One reason for this good result may be the large flat area of hull immediately above the propellors, which stops air being drawn in.

A number of points were then raised in a free discussion, which would be better reported verbatim, since they covered several interesting and informative points.

Professor Bruun:

I have a few comments to make of a strictly technical nature, and a number of an operational nature. Mr. Gifford has said that variations in profile steepness have to be considered. It happens that during the last ten days I have measured the variations in steepness on the very beach at Lagos to which Mr. Gifford has been referring. I found the steepness to vary from 1 in 4 to 1 in 22. I do not know the frequency or distribution of these steepnesses, but I think the mean was 1 in 7 or 1 in 8. I understand from Mr. Gifford that this presents no problem.

As to operating conditions at Lagos, Mean Wave Height varies between about 0.7 m in January and 2.0 m in July/August. Breakers may be 4-5 m high, with long 14-16 second swells (as observed on 25 June 1975) which are probably relatively infrequent. This means that uprush velocities may be 2-3 m per second under moderate conditions, but 6-8 m per second during more extreme conditions. Skids must be designed to be stable under rather high velocities and also stable against sinking due to scour. Hardwood may not be heavy enough and cast iron or reinforced concrete, of streamlined geometry and with wide footing, may be needed.

The possible frequency of operation is very important. We need to be able to relate operational capability to wave action - that is, to breaking wave height (H_b), and also to wave period (H_b/T^2). It is very necessary to have a clear picture of the conditions under which a vessel can operate. If a certain type can operate on a greater number of days, then fewer vessels are needed. From what I have seen this type can increase efficiency, and therefore economy, very greatly. By efficiency I mean not only the number of days on which they can operate, but also increased efficiency during operation. At Ibiju, 13 km East of

Lagos, a village of about 300 inhabitants, one large canoe - 7 m long, 1 m wide and 1 m deep - is, according to the local people, the only boat they need. In Norway and many other places we have changed from 5, 10 or 15 ton Sharks to factory vessels up to 1 000 or 1 500 tons. This is economy. Technology should not be adjusted to people; they should be taught modern technology, which in turn will increase their income, standard of living and safety. One surf-going vessel, for example the catamaran, might replace 20 canoes, because it can operate more efficiently and on more days. If its probability of operation, the probability of getting out through the surf as compared with a normal canoe, is increased by a factor of two, and its efficiency three times, because it can carry more nets and place more during a single operation, then the total probability of improvement will be six times. It will take some time to make the necessary adjustments, but I do not think that it will be too difficult to establish a more efficient operation based on surf vessels. But we need data in order to be able to evaluate the technical and operational capabilities of these boats and so provide the economists with reliable data.

Mr. Gifford

I am very impressed with the figure for surf that Professor Bruun has obtained from Lagos. I did have the feeling that surf of these dimensions might well occur there, but it is probably rare, I would expect that during surf up to 5-6 m high, not many people would want to go to sea. But in general we found that on the Nigerian coast we were going fishing on many days when the canoes were not. There was in fact one period when the canoes had not been out for three weeks when the Catfish was going in and out quite happily. The canoes were stopped by much less severe wave conditons - probably in fact much the same kind of surf as was shown in the pictures from Ghana. The Ghanian fishermen are a little more experienced in heavy surf than the Nigerians, who tend perhaps to stop fishing a little sooner than they do in Ghana. I think that the Catfish, at any rate on the West African coast, could probably go fishing for 350 days in the year - the extreme conditions are, I believe, quite rare. That would certainly give a much more powerful fishing capability and efficiency than the canoe. As to the number of people engaged in the fishing, the fishermen in Ghana refer to the net as the important item. The boat serves the net and is simply an ancillary part of the equipment which takes the net out to sea.

In reply to Mr. Gurtner, we are clearly in agreement on many things, and of course I did not put forward our proposal as an exclusive solution. But I would query the basic validity of his comment that the craft should stand on its own, economically self-supporting, while the installation could be allowed to carry a subsidy. I am not an economist, but it does seem unusual. Certainly, as far as most of Europe is concerned both the craft and the installation would carry a subsidy. It seems to me that the fishing operation ought to be considered as a whole. If we are able to develop between us a craft which in certain situations does not need shore installations, in place of a rather cheap craft which requires very expensive installations, then the whole system should be taken into account, including its life - and the life of the boat will of course be less than the life of the installation.

Mr. Adam

I agree with Mr. Gurtner that timber would not bring about any saving, not only because of the price of timber, but also because of the difficulty of finding the specialized manpower necessary, even for the relatively simple construction of this catamaran. As to the boat being financially self-supporting, I completely agree that this is indispensable. Subsidies given in many countries for fishing vessels have recently been followed by subsidies paid to fishermen not to operate vessels which cannot fish any more because the possible catches are below what the vessels need to be viable.

I would also like to refer to the catamaran itself. Obviously, it is an excellent solution for surf riding, but in my opinion its greatest drawback is its speed when weather conditions are unfavourable. Certainly this catamaran can go out in conditions when no canoe dare. When it is out the catamaran is satisfactory if it has to trawl, because trawling speed is limited. But to cover a distance to the fishing grounds becomes extremely

difficult when weather conditions grow worse. For fishing vessels generally the ratio: speed/$\sqrt{\text{length}}$ is about 1. I feel that with catamarans in normal, or shall we say less than excellent weather, one has to reduce speed for reasons of safety to something approaching .7, which means that it is a very good machine for fishing but a bad one for steaming. Of course, sport catamarans can sail very fast indeed but the discomfort is significant and the cargo practically nil.

Finally, in order to reconcile the catamaran and the single-hull boat may I suggest that Mr. Gurtner should design a one-hull craft which Mr. Gifford would then transform into a trimaran.

Mr. Gifford

I am anxious to avoid any suggestion that I am hostile to mono-hull boats. We simply produced a multi-hull design because we felt that for certain circumstances this gave the best answer. I am not in fact a catamaran enthusiast, apart from this particular application My own boat is a mono-hull and will remain so. I certainly believe that there is a place for mono-hulls on the beach in certain circumstances. I think that there is something in what Mr. Adams says about speed, but it is possibly a little exaggerated - I think he is considering racing sailing catamarans, which are totally different - it depends very much on hull design. It is true that we have to slow down in short, choppy seas but only, I think, to a factor of about 1. We have a water-line length of 34-35 feet and a normal speed of about 8 knots, a ratio of about 1.2. When it becomes relatively choppy we slow down to about 6 knots, but we do this not because of slamming on the bridge deck - the waves hardly make contact with the bridge-deck, even going through surf - but because of the flat-bottom hull shapes, which are there to facilitate beach landing, we do get some slamming under the forefoot. So one slows down to meet a short head sea, such as one gets in the English Channel which is much more unpleasant than the kind of sea normally met in the tropics.

On the question of timber, the position varies, of course, enormously from place to place. At present timber prices are going down because of the world situation. It is simply not true that labour is not available, that is a great generalization. In Nigeria or Ghana, for example, there is a good deal of first-class skill in carpentry - not only in boatbuilding but in carpentry, which is what is needed for this type of construction. In other parts of the world there is no timber or skill. Glass-reinforced plastic construction is quite satisfactory; we can design boats in whatever material is appropriate to the situation

Mr. Gurtner

I agree with Mr. Gifford that there is no question of opposition. On the question of speed, I think that it might be a good idea to bring the speed/length ratio down to .7, on economic considerations. As to comfort, when travelling in choppy seas and bad weather this is a very important point, but unfortunately if we ever succeed in developing a mono-hull configuration that can do what Mr. Gifford's can do, it also is likely to be rather uncomfortable. The sheer necessity to keep draft low, for a given length and a necessary given displacement, will mean a rather incredible beam. Obviously, it is essential to have a relatively flat-bottomed boat for ease of beaching - if we want to beach. We do not, perhaps, need to think of shallow-draft boats only in terms of beaching; they have other uses also.

This little V-bottom boat (type BB-59) is a beach boat which we built in India in 1959. It behaves extremely well in very rough conditions because it is not an extreme shape, but is designed and built with the coble much in mind - the best hull-shape and resistance characteristics for difficult sea conditions. And that is precisely the reason for the boat's lack of success. Technically it is a successful surf-boat. The full-scale version was intended to operate in plunging breakers, up to a limit of about 6 feet. It did that very well, but it has insufficient capacity to be a really successful fishing boat; it would be necessary to increase its catching power to the point at which it could make itself pay, as against the increased cost. So this boat is not the answer.

Mr. Fyson

Mr. Gurtner has indicated FAO's present approach to beach landing boats - the single-hull solution costing about twice as much as the canoe. Mr. Gifford has made a very valid case for using the catamaran, in that the large beam renders beach landing much simpler, so that the boat can be driven on and off the beach with very little skill. That is most interesting. His films showed the problems that the canoe-owner can meet and the great skill needed to take the canoe through the surf. If, therefore, a single-hull solution is introduced as a replacement for the canoe, will we meet the same problems, the same risks of broaching, capsizing and the loss of gear and fish, to such an extent that the catamaran is a more valid answer, even if more expensive? We have in fact been experimenting for a long time with the beach landing of single-hull vessels. There is an article on this work in Fishing Boats of the World, Volume 3 (pp 519-20) (Reference No. 37). I was involved in this at the beginning in Senegal and Mr. Gulbrandsen carried the work much further in Dahomey. The illustration (see pp 519-20) shows the lines on which we were working; it is a simple installation, involving a heavy anchor or series of weights - about 400-500 lbs - placed outside the surf-line, with a float to which a long line can be attached and brought in to the beach. This is normally pulled fairly taut. The advantage of keeping the rope taut is that: (a) the risk of broaching is reduced; (b) control of the boat is improved, and (c) pitching is reduced, which is important, particularly when going out. This system was used with the boat shown in the small illustration. We went out regularly in wave-heights up to 8 feet. It was exciting, I must admit, but we had no serious problems and did not lose or capsize a boat with this line system. So I think that there are valid solutions for a small boat.

For larger vessels, perhaps of the same order of cost as Mr. Gifford's twin-hull boat, we are thinking of another solution and there is an FAO/Government Cooperative Programme proposal for the evolution of shallow-draft mono-hull vessels. These would not, however, be intended for landing directly on the beach, though they might be able to do so in ideal conditions and be hauled up by a winch. Basically, they would be intended to cross bars into shallow rivers. I hope that this conference will produce some ideas and costs for finger piers and other low-cost harbour structures for use by very shallow-draft boats, so that these would not have to go through the beach-landing operation but could unload their catch, and possibly even take shelter, in fairly shallow water at not too high a cost for port structures.

I would like to ask Mr. Gifford one or two questions about his Catamaran. What is the fish hold capacity of the catamaran? At what wave heights were you regularly able to go in and out during the trials without serious problems? Was there a danger, with larger waves, when going out stern-first, of being swept by waves, and if you were carrying trawl or gill nets on the deck was there a risk of losing gear, or of having it so entangled as to create difficulties for the fishermen operating it later?

Gifford

The fish hold capacity that we have set at the present time is six tons, of fish and ice together. This is very modest, still giving about 2' 6" of freeboard. With the experience that we have had we could, I think, increase capacity up to about perhaps 8 or 9 tons.

Landing is much easier than departing, and so we are never swept when coming in. Even if we were, flooding dangers could be overcome, for example by raising the hatch combings. It is therefore reasonable to assume that the boat has a greater capacity than was at the design stage. Of course, if the freeboard is reduced, to increase capacity to roughly 9 tons, draft will be increased to something over 3 feet aft, which means that the boat will begin to ground while still in fairly bumpy surf, so this extra loading would be dependent on weather conditions.

As to wave operating heights, we have not yet been stopped. Admittedly we have not tackled waves more than 7-8 feet high, but at that height there were no problems and I am confident that, bow-on, that figure can be

In the stern-on situation we have differing views. I am inclined to be cautious and prefer to turn and go out bow-first; others think that the boat would be capable of going out bow-first through much bigger waves than we have experienced. In fact, the boat is not so much swept by waves; a large quantity of water is, however, dumped on the deck and does not flow off quickly. This weighs the boat down a little and gear does need to be secured under these conditions. So it seems easier to turn as soon as the boat is reasonably afloat and go out in comfort.

Mr. R. Moor (Peru)

Considering possible solutions to the beach-landing problem, the vessels in use at present in Peru, in the regions of San Jose and Santa Rosa, cost less than 10 000 dollars, so the catamaran is quite expensive. Can Mr. Gifford say how his vessel would perform in Peruvian conditions, where the wave period is very long - a range of 10-20 seconds with periods of about 14 seconds predominating - and the foreshore is about 1 in 50, the inshore beach about 1 in 150? On this very shallow beach the waves sometimes start breaking 400 meters out from the beach.

Mr. Gifford

It is difficult to compare costs when one is not sure what is being provided for the money. One has to compare like with like. Costs in the UK are bound to be higher than those for boats built by the local fishermen in many parts of the world. I believe that what we are proposing would be of the same order of cost as boats of comparable fishing power - perhaps a little more expensive, but of the same order.

The wave conditions described by Mr. Moor are very similar to those experienced on the trials recently completed in Cornwall - the same beach-slope, wave period and wave height. On the last day of the trials the wave height was about 7-8 feet (2½ meters) and the period about 15 seconds. The boat behaved well under these conditions.

Mr. W.J. Guckian (FAO)

In a recent FAO/World Bank Mission to India, we obtained some figures for boat costs which may be of interest. The cost of a 12-14 meter boat, built of timber on the West coast, with gear (generally for trawling), was of the order of 15 000 dollars. The corresponding price for fibreglass, mass-produced, was about 18 000 to 28 000 dollars for boats ranging from 13 to 18 meters.

In Honduras the fishing is at present by canoe. One man operates a 3 meter canoe, three men handling a 4 to 6 meter canoe with a small gill net. The fishermen cannot afford to buy these; they are rented in exchange for half the value of the catch. These boats are going to be replaced by 32-foot (about 10 meter) fibreglass boats, at a cost estimated on American prices of 35 000 dollars. A lower-priced beach boat than this is an essential introduction in these circumstances.

In Java in 1972 such a Mission was given figures of fish landings which, however, may no longer be up to date: 800 tons of marine fish were landed, mainly by 1-3 man canoes, involving perhaps 850 000 people in this small-scale fishery operation. The most optimistic estimate of the possible increase in landings was 10 %. An effort was made to acquire 1 000 mechanised craft, which would employ 4 000 men - and take away the livelihood from perhaps 100 000 men. The fish would be sold at half to two-thirds of the existing price, thus taking away the livelihood of perhaps another 250 000 men. It isn't easy to see the answer. There is, I think, a parallel in the case of the catamaran, or the 15-16 meter mono-hull, as against the canoe. I will put forward this question - do we always really need a larger boat?

Mr. Gifford

If the larger boat is to be fishing the same grounds there seems to be no point in introducing it. The important question is whether the new intermediate boat will give people the capability of fishing new grounds. This is particularly relevant with changes in the laws of the sea, where other vessels may be excluded from a country's fishing grounds, giving the country the opportunity to fish them themselves. I think these are the sort of circumstances that justify the new boat. As to price, 28 000 dollars for a 14-meter fibreglass mono-hull boat (allowing for the fact that the twin-hull boat is the equivalent in terms of power of a slightly longer mono-hull), is probably a little cheaper but not significantly so. Also, it should be noted that our two twin-hulls are the first of their kind that have been designed by us, or indeed by anybody, and there is a great deal of room for optimizing economy in construction.

Mr. van Steenwijk

We had in Holland, in the 19th century, a big square fishing vessel, the Boomer. They were beach-landed and they had a very short life - 4 or 5 years. Did you carry out any durability tests, for example by hitting the beach 20 or 30 times?

Mr. Gifford

The boomer was of course a mono-hull boat, a large, heavily-built timber vessel with considerable draft, which would have grounded where the surf was fairly high and would therefore have received considerable pounding. Timber craft at that time were of a sort of basket-like construction, and since the joints and fixings were doubtful, very massive timbers had to be used. With modern techniques, using glues and resins and sheet material, the durability of craft is much greater. However, the important point is that we avoid pounding, and if a boat can be designed to have only 2'6" draft, then whether it is a mono-hull or a multi-hull, it will not be pounded. We have not, however, been operating long enough yet to be able to produce evidence of durability.

Mr. van Steenwijk

Apart from the pounding, if a boat is lifted out of the water or thrown up on the beach, it must be harmful to the engine.

Mr. Gurtner

Constructional techniques have certainly advanced tremendously in the last 50 years. It should be remembered also that in the 19th and at the beginning of this century, most of the mechanised timber fishing vessels in use were derived from sailing craft and were built to quite a different constructional standard. They did not need the stiffness that an engine requires. This is no longer a problem.

I would like to comment on Mr. Guckian's point about the landing of 800 000 tons of fish in Indonesia. The basic problem is that, before one considers either replacing canoes with small boats or introducing what we have come to call an intermediate fishing boat in across-beach operations, one must first consider what the boat is supposed to do; what resources will it have to use? The answers will set the economic base for what the boat will actually cost. In short, you must start with the fish. It is of little use to consider only the price of the boat and to decide that one looks too expensive, one seems about right, without examining the whole picture - the price of the vessel, its cost in relation to the catch, the price that can be obtained for the fish on the local market, the possibility that, because the vessel lands a better quality catch, this can be processed or transformed into a product that is not necessarily consumed in the immediate area in which it was caught but can travel. This in turn may open up an export market with larger earning possibilities than a local market could provide. It is a very complex question. I do not think that there is a serious technical problem; the only problem is that the technical

solution has to match the economic possibilities. This at times can be very difficult.

One objection to the use of the twin-hull vessel in my country is the use there of reconditioned engines, which are available in a very limited range of sizes, say 60 to 80 hp. To use a twin-hull would mean either installing engines which are too large, or buying expensive new engines which would be very costly in relation to the total capacity outlay. With small boats, fishing is confined to a small strip of coastal water and this has already been fished with standard resources to its maximum capacity. To increase investment would not therefore increase production very much. I wonder how this can be overcome?

Mr. Gifford

We started with the two-engine concept for a number of reasons; to give manoeuvrability and to obtain maximum power from the installed horsepower, by locating the propellers under the hulls. There is one man in the UK who is operating a practical fishing catamaran, of about the same size as ours, which has the engine installed on the bridge deck, with an inclined shaft to the propeller low down aft. I have seriously considered this arrangement, but it does sacrifice some of the remarkable manoeuvrability achieved by the twin engines - which may indeed be a great deal more than is necessary for practical fishing. We could perhaps turn in the surf with a single engine installation. I hope to try this out. If it successful it would mean that one of the 60 HP engines referred to by the last speaker could be installed on the bridge deck. It would be necessary to change the layout of the deck but plenty of deck space is available and this could undoubtedly be done.

As to the coastal strip being already fished to its maximum capacity by the small boats, there are fish beyond this region and at present there are not boats of sufficient range. It is necessary, therefore, to solve the beach problem.

Mr. Wong Kim Yok

I do not think that it is a beach problem; the problem is to provide facilities for keeping fish fresh for more than a day or two.

Mr. Gifford

If more powerful boats can be built that can go much further and exploit resources which at present are not being exploited, this would be the intermediate boat to which Mr. Gurtner has referred - whether it be mono-hull or of any other design. Provided it can meet the special engine requirements, this approach would seem to me to suit the Malaysian situation.

Mr. Guckian

On the West coast of Malaysia in Penang, the vessels are of shallow draft, about 2'6", with reconditioned engines. They go out in the morning and return at night. This pattern was set by the customs of the Chinese fishermen rather than by the ice-carrying capacity of the boats; some of the boats did take ice and could have stayed out all night. There is certainly an artificial restriction in this case.

I would like to thank Mr. Gifford for a Paper which has stimulated a very wide-ranging and lively discussion, and will no doubt help those who have problems in this field. As in all engineering situations there is no unique solution to all problems, but there are solutions which can solve individual problems and can have widespread application.

4. SESSION III

Static Structures - e.g. Open Jetties, Breakwaters - for Use in the Development of Small-Scale Fisheries: Introduced by Mr. J. Pilon

Mr. J. Pilon

In this paper I deal with Static Structures - jetties and breakwaters - used in the development of small-scale fisheries, in their relation to the natural conditions to be found on a sandy coast. There are two types of sandy coast; open shores interrupted by tidal inlets or estuaries, and open shores with littoral drift. An open shore interrupted by an inlet or estuary can be in equilibrium, it can be eroding or it can be growing. Everywhere the estuary is either changing, or in equilibrium; this may be due to the sand transported by the river. The transport of sand by the river may cause difficulties, changing the river discharge. If a dam is built in the river, as in Egypt, the amount and type of sediment transported is altered and the coast starts to erode. If the amount of sand or sediment transported is high, as for example in the Rhone, the river delta grows out to sea.

On an open shore with littoral drift, the same situations can occur - equilibrium, erosion or growth. A coast built up of sand has a changing character under the influence of waves and currents. However, you get quite a different idea of a sandy coast if you look at it at high water, from that which you see at low water. This can cause difficulties if you rely on other people's ideas of what is happening on a coast. Occasionally on a trip along the coast I am told that the coast is changing very much. In fact nothing is happening, only that the water level was different at the time of the visit from what it was at another time or on another day, or during a storm or in calm weather. The surface of the strand may be flat, but not necessarily so; it may have ripples. If you see a beach at low water and again at high water you may see many ripples. If you return after a month and see no ripples you may think that the beach is changing very quickly, that sand is lost or that sand is brought in by waves and currents; but you cannot be sure of this. We have therefore made measurements on a northern part of the island in the Netherlands, on a coastline 2 km long, over a year, and have found that all changes were changes from the winter situation to the summer situation: no sand had been transported by littoral drift.

To get a true idea about such things you must sample the data. I do such sampling every day in my work.

In effect, the surface of the beach is modelled by nature - by waves and wind. Difficulties are also caused by wind, which can blow along the beach and transport much sand. I can illustrate an example on the Netherlands coast where there is a small fishery harbour. The harbour authority people have said "we must dredge the channel; sand is blowing over the beach and is causing the depth on the channel to vary. We must have adequate depth for the fishing boats." Research of the problem has shown that the channel is not changing but that the surface of the sand bank is. Aerial photographs can be very useful in studying such things, but they must be interpreted correctly to obtain the true situation.

In the Netherlands we have both types of coast: open shores with littoral drift and open shores interrupted by tidal inlets or estuaries. Small fishery harbours have been developed and built on both types of coast. On open shores interrupted by tidal inlets, the harbours are controlled by sluices. Behind the sluices is the polder - land below sea-level, of which we have a great deal in the Netherlands, through which water is discharged into the tidal inlet. Nearby, houses are built on the dykes. The layout of these harbours differs from place to place but the principles are the same. By low tide the water is discharged into the tidal inlet, and this is important because the tidal movements cause silt and sand to be deposited in the channel, but this is removed by the stream of water discharged through the sluices. This happens not only through the flow of water but also because of its different density. The water from the polder is fresh water; that in the inlet is salt, and the two do not mix easily, so there is heavy turbulence and this displaces the silt.

These harbours are built of local material. In the past much use was made of mattresses or fascines, woven from willow branches cut every five years. These are pinned down to the face of the dams. These withstand the action of the water and trap the silt. This is a very good construction; there are examples in some harbours in the Netherlands that have lasted for centuries and are still operating very well. In other places the dams are constructed with timber alone; these have given some trouble in the past. Later dams were made of stone in several places. These harbours are naturally located in a gulley in the inlet. There are two types of such gulley - flood gulley and ebb gulleys. With both it is possible to maintain depth in the harbour to some extent by using the rush of water from the polder. These small fishery harbours are used also for agricultural products, which are transported by water to the little towns in the neighbourhood, on other islands or along the coast of the Netherlands.

As to open shores with litteral drift, there is a long beach from the Hook of Holland to Den Helder. In the past, landing operations were across the beach, the ships standing stern-on to the shore. To pass through the breakers is difficult and has created many problems along the Netherlands coast in the past. Moreover there is a further problem that during storms the ships may be lifted by high storm tides and washed up into the dunes. Many ships were lost in this way. And so, some 80 years ago, the government decided to construct new fishery harbours on the south coast, on an open shore with littoral drift. Thus we got the harbours of Scheveningen, Den Helder and Ijmuiden, where most of the fishing craft concentrated. After the severe floods of 1953 and the adoption of the Dogger Plan, all ships are now concentrated in these harbours since that date.

It is important in such harbours that the approach channel should have sufficient depth and that it should not pass through the breaker zone. In recent times there has been much discussion with nautical people, and general agreement has been reached on the design of harbour entrances. As civil engineers we can design harbours, but the people who must use them are not civil engineers but fishermen and it must be made as easy as possible for them to enter and leave the harbour. In particular, the entrance must be safe for them during heavy weather.

In general, the construction of static structures in coastal areas disturbs the equilibrium of the nature and amount of this disturbance, but some idea of it can be obtained from measurements made before the work starts - a detailed reconnaissance, including basic engineering surveys, are essential.

Mr. Pilon, with the aid of a map and some sketches, illustrated some of the ways they have protected sections of the Netherlands coast most open to damage by drift.

In certain locations earlier groynes were erected and destroyed by bad weather conditions. At many points extensive groyne systems were erected since the flood disaster in 1953.

For a considerable period there was much discussion and many experiments conducted to determine the length, the spacing and the angle of the groyne to the coastline which would give best results. As a result, smaller groynes were constructed; the actual distance between the groynes was, however, a very important factor and was found to vary over many different parts of the coast.

There are three main types of groyne; those of stone and bitumen, those of timber posts and those formed by piling up sand. Each has its own advantage, but there are several disadvantages too, e.g. the cost of maintaining structures such as timber posts, and the provision of rocks - a scarce commodity in many parts of the Netherlands.

Always one must be careful never to disturb natural conditions, one must have full information on what is likely to happen, but this is frequently not easy.

With regard to constructing breakwaters in the Netherlands, we do a great deal of measuring of existing conditions before starting work, for model studies, for basic engineering surveys, to enable a number of alternatives to be examined. When working on a coast, both in the Netherlands and in other countries, the history of the coastline - what has happened in the past must be studied. Thus you get a picture of the coast and how it has changed in times past. Old charts and maps may give much information. In some localities it is possible that detailed soundings may have been made by hand; we have sometimes found these recorded on maps of the 17th century. These give a real picture of the development of the coastline in the region.

One of the questions to be asked is - is the coastline in equilibrium? Is it growing or has it been growing? How much erosion has occurred? On some parts of the Netherlands coast the shore is moving back 700 meters in a year - a great deal. If we study the maps we can see that the coast was more to the west than today. Meteorological data is also important, particularly records of wind. In several countries the rainfall over the year, and the frequency of rainstorms over several years, is also very important. This is not so important for us, but we are aware that the discharge from the Rhine changes from year to year, so that the amount of sediment that it brings to the coast varies to an important extent. We must also know the frequency and direction of winds over a full year. It may be possible to obtain this information for several years back. Even more important is a knowledge of what happens during storms - and hundreds of storms may occur in a period of ten years. On the Netherlands coast we may have only one severe storm in a year, or we can have as many as five. And the effect on the coast of one storm in a year is qui. e different from the effect of five. For the design of some structures the depth of water is very important - and changes in the depth can sometimes be seen from old sea maps. The underwater contours may be parallel to the shoreline but this is not usual. Changes in the contours are of great interest. Information about erosion and about the stability of the coast can give an indication about the future. When designing structures one looks for deep water close to the shore, to give short structures and short shipping channels. This is also very important for economical maintenance, especially in the small-scale fishery sector.

Information is also necessary on tidal movements - normal tide, low water, high water, Spring Tides. It is even more important to know the water levels during floods and the frequency of those floods. This will give valuable information about the coastline. Waves must also be measured. Wave measurement is carried out all over the world in different ways. In my department in the Netherlands we use poles, placed in water depth of 5 to 10 meters below mean sea level, with the necessary instrumentation; wave-amplitude recorder or electric step-gauge. Both instruments give information about wave height over a period. The wave-amplitude recorder, which we have used for 20 years, is a very reliable instrument, but the wave-amplitude worked out from the recordings takes a great deal of time. We have therefore developed in our service a new method, which reduces the time required by half. We have 11 of these poles, which indicates the amount of work that we do. The electric step-gauge makes it possible to work out the recordings by computer, but I believe that in several countries this has been a more difficult exercise.

With wave measurements over a couple of years one has good knowledge of wave movements in an area. But it is very difficult to find out what happens during floods and storms - how rapidly does wave-height increase? I have seen wave height increase in 2 hours from 30 cm to more than 2 meters. Obviously wave height is important in the design of a structure. Knowing the wave height it is possible to design more economically. This applies particularly in the design of fishery harbours. In those countries where money is limited it is very important to have full information - for instance, for what wind direction is wave height at its greatest? and is it at its highest for a few days or for a month in the year? Analysing the wind direction makes it possible to achieve more efficient harbour designs. Another factor is the wave period. Along the Netherlands coast we find waves of 6 seconds period, but also of 15 seconds period when the wind is from the North - from the Atlantic. If there is a storm there it can generate waves of even longer period.

If one is making a survey, then sampling of the bottom may be important. At first, in the Netherlands, we thought that we should know if the grain-size is 150 or 200 microns. More information was not important. Now, with larger and larger constructions, we need more information. If samples are taken across a typical beach several sizes of grain will be found. On the beach it may be 150 microns. In the dunes smaller grains will be found; 140-150 microns. In the breaker zone the grains can be 200 microns; further out 300, 400 or even more. What has happened is that the grains in the breaker zone become smaller and smaller. Sand is blown to another area and back again to the same place; this may be material of 50 microns grain size. There may be a proportion smaller than 50 microns - as much as 10 %. When designing structures it is important to know the grain-size outside the breaker zone, especially if local material is to be used. And so bottom-sampling is becoming more and more important, both along the coast of the Netherlands and in the North Sea. Something else can be found by sampling - the percentage of silt present. The amount of silt present will give an indication of the current velocity at the bottom; the more silt, the lower the velocity. This can be useful to know in a first survey of local conditions.

As to current measurements; the normal procedure is to take measurements from a measuring vessel; a small vessel may be used in a coastal area. For measurements in the open sea a larger vessel would be necessary. In order to measure the current from a vessel the weather must be suitable; wave height must not be excessive. There are now instruments that can be laid on the sea bottom or at various depths. In the Netherlands we are fortunate in having 10 to 20 of these instruments, which we use in order to obtain data about conditions along shipping channels. Normally, the instruments are laid down for 28 days - that is, two tidal cycles. In normal weather conditions, it will be seen that current velocity and current direction do not change very much. This can be learned also from the measurements taken from a vessel. But during storms quite different types of current velocity and direction will be observed. Directly after a storm, when the water is seeking to regain its old equilibrium, current velocity will be at its greatest. For example, in a channel where the current maximum is 50-70 cms per second, after a storm it can be 100-150 cms per second. So, if you find yourself in a region that you do not know well, it is a good idea to install instruments at a time when storms can be expected. During and after storms, with large current velocities, and with current directions that are not found during normal circumstances, there may be a greatly increased transport of sediment. We have been finding, in some places in the northern part of the Delta region, that after a storm millions of cubic meters of sand have been moved from one area to another. Naturally, this is undesirable. If something can be learned about these things one is better able to design coastal structures.

Another way of making measurements is by floating poles. These will give an indication of the current direction - whether it is normal, parallel or at an angle; the same sort of pattern can be obtained as in a model. We use these very often in the Netherlands; they give a good idea of the whole situation in an area.

In recent years we have also done a lot of measurement of silt and of chlorides - salt in water. It has been known in the Netherlands that in a normal situation in a polder at the point of discharge of water where new land is growing, at the side where fresh water flows into the salt water there is heavy sedimentation. This occurs along the northern part of the Netherlands and at several other places. When fresh water and salt water come together sedimentation is always possible. This can be observed in a new channel which has recently been dredged into the North Sea for the Rotterdam waterway, where silt is being deposited 25 km off the coast. One can see from an aeroplane over the sea the line of separation of the two types of water. The fresh and salt water do not mix quickly, so that the line of separation can be followed for 15 km from the coast. Samples taken from the two sides show marked differences in sediment and salt in the water. The same thing can be seen in the mountains when two rivers meet; one from an area where it has been raining, carrying silt, and one from an area where there has been no rain, bringing clear, fresh water.

We use aerial photographs very often in hydrometry, especially in the neighbourhood of harbours. At the fishery harbour of Scheveningen there is a little inland channel which is not used frequently, but which brings fresh water into the harbour. We have made aerial

photographs and have set up measurements, which have shown that there is more silt in the part of the harbour where the fresh water enters than elsewhere. It is not necessary to have special photographs - ordinary good quality black and white are quite satisfactory. In several African and Asian countries the governments have had extensive aerial photographic flights made, for survey purposes; these records can be used to good purpose.

I have said something about measurements. During my work in the Netherlands people from many parts of the world have asked us what measurements should be made in coastal areas. If they are told to use instruments they think that this is quite easy to do. Unfortunately it is not easy to interpret the results of such measurements when designing a harbour or other structure. Too often, the designer thinks that he knows what is happening. Professor Bruun spoke about the 17th century Netherlands engineer, Andreas Speerling. We work today in the same way as he did in past times. Whatever is constructed, the disturbances caused should be as small as possible. And so in the design of harbours, or breakwaters, or in any coastal engineering, one must proceed step by step, gathering information, getting experience, learning more and more about the possibilities; learning from nature.

I would like to say something about breakwaters. Naturally, there are many possible ways of constructing breakwaters. In designing harbours, however, it is very important to make certain decisions. It is possible to construct a harbour with breakwaters which will require a great deal of dredging every year to maintain it. Is this important? Or is it more important to give protection against waves? and waves from which direction? It may be decided that maintenance must be small and so a harbour must be designed that will require very little dredging, or it may be decided that a harbour should give protection only from one direction.

The handling of ships has already been mentioned. The navigational quality of a harbour is very important. In the Netherlands we give more and more attention to this aspect, not only in major harbours but also in fishery harbours. Talking with fishermen gives a good picture of the problems where angle and width of the harbour entrance can be very important.

I have spoken of the material used for constructing breakwaters in the Netherlands. In the past and again at the present time we have used local material. This, I think, is especially important for countries planning to build new harbours for small fisheries - what materials are available close to the coast? Does the stone, the grain-size of the sand, make concrete possible? Is timber a possibility? In the Netherlands we have had, since the second war, difficulties with foreign currencies and this has led naturally to the idea of building dams and dykes with the material available in our own country. In the past we used basalt for the dykes, but this must be imported from Germany or France and is very costly. So we have changed over to sand, to asphalt for the wave area, and to gravel for the filter layers. Air vents are also necessary to allow the escape of air compressed in the upper part of the breakwater when water-level changes in the dyke.

We have learned, therefore, from the work that we have done, that we must use the material that we have in our own country. From what I have already heard here, I think that this must be the approach in other countries wishing to develop new harbours for small fisheries where the use of well-known m thods can be very important. The local people can work together to make dams, breakwaters and harbours by methods that they know. On the other hand, as in the Netherlands, progress with new materials and new ideas is also important.

When the work has been completed and the harbour is ready it is most important to continue making further measurements, to find out what has happened after the construction of the harbour. Difficulties may occur in the future, but if you have the information that measurements can give, you may be able to anticipate difficulties and take measures to prevent them. One hopes that difficulties will not arise, but at least the continuing measurements will make it possible to foresee them.

In conclusion, I hope that I have been able to give you some ideas that will be useful in the development of small-scale fisheries and in the design of structures along difficult coasts.

The Chairman thanked Mr. Pilon for his fine presentation, in which he had illustrated so many of the great difficulties experienced by civil engineers along the coasts of the Netherlands. He requested comments and questions from the participants.

Questions

On a number of questions asked and comments given by, amongst others, Professor Bruun, Messrs Delap, Gifford, Baratono, McGrath, Moor, Guckian, Breimer and Bhakta, the following replies were given:

Mr. Pilon:

(i) Somewhat similar conditions to those of the sandy beach of Holland San Felice Circeo, about 90-100 km south of Rome, w re recent arti have caused serious erosion to extensive sandy beaches which had been laboriously built up over the centuries. On illustrating the approximate data, Mr. Pilon was requested to explain the reasons. I have known the situation at Sabaudia and San Felice for some years, and I am aware that the wave action there can in certain circumstances be high for the Mediterranean. I think that the structures built there have combined with the wave action to change the direction of the currents along the coast. So, on one side sedimentation is possible, while on the other side the change in current direction means that there is erosion. But as I have said before, you must take measurements in order to know precisely what is happening. The situation is somewhat similar to that occuring on the Netherlands coast in the neighbourhood of Scheveningen. There we built a new harbour breakwater out in the sea. Model investigations showed the current direction to be parallel to the coast. However, we took measurements and found that the typical current direction for some hours of the tide was at an angle to the coast. I asked myself if the measurements were correct. Then I visited the beach and found tomato skins that had passed out through a sewer, floating off the beach, and moving in the same direction as indicated by our measurements.

At this point, Dr. Baratono (Italy) gave the following supplementary data on Circeo, since it was his office that was dealing with the problem:

> Between San Felice Circeo and Terracina over the last few years the sea has eroded the coastline repeatedly, near San Felice and near Terracina. A study has been undertaken to find a solution that would slow up this erosion. The principal wind directions have been studied, but it has been observed that the most dangerous is that from the south. Among the various solutions that have been examined - breakwaters, artificial islands, submerged groynes - the T-shaped breakwater, placed at intervals in such a way as not to disturb swimmers and tourists, would seem to be the most suitable.

More information on the Circeo problems was provided on loan from Dr. Baratono's office files to be read by interested members of the Consultation. This included results of all surveys, and an historical review of the situation.

Professor Bruun also gave the following information:

> I do not know this site, but it would seem that we have the beginnings of a tombolo; this is in fact a typical case. When waves come from one direction, counter-currents are set up, eddy currents, which deposit sediment because of loss of energy. In other words, the regimen of the shore is changed. As to T-groynes, these are well-known in Italy, and I think in Spain, in Massachussetts, on the Danish west coast and elsewhere. They work by changing the characteristics of the wave-action. Instead of waves with a steepness of .04, .05 or .06, which will flatten the beach profile, the steepness ratio is lowered.

Laboratory experiments will show that the dimensionless ratio, H/L, or HO/LO, is critical at about .025. If the ratio is higher than this the beach profile will flatten; if it is lower the beach will go the other way, becoming steeper. A great number of beach profiles have been studied in Denmark, and it is found that in certain years the profile varies in one direction, in other years in the opposite direction; the direction is related to the wave-form. In California, in Mission Bay, the critical ratio as between building-up and eroding waves is more nearly .01 (that is, height 1, wavelength 100). With these T-groynes, the wave-height outside may be 1.2H, and this is reduced by the groyne to .5, .3, .1, changing from a steep, eroding wave to a constructive wave. Many years ago I experimented with T-groynes and found that the spacing can be adjusted to local conditions. In Holland the spacing is, I think, 1 to 1 - spacing equal to the length of the groyne - or 1 to 1½. On the Danish west coast the spacing is 1 to 2 or 3. In Italy and Spain spacing up to 1 to 4 or 5 is satisfactory.

Mr. Pilon's presentation is very important. It is important to discuss how inexpensive structures may be provided for small-scale fisheries and fishing port facilities. Mr. Pilon referred to willow (fascine) structures, and the very streamlined Dutch groynes which consist of a core formed of anything from sand to rubbish, or other quarry or structural waste, armoured by basalt prisms and rock pavement of various types. Such structures may be used at low to medium exposed shores, as is the case with the Dutch groynes in North Holland.

On more exposed shores, structures of sturdier design are needed. For small-scale port installations designs have to be simple and economic. If rock of the proper size is available the "conventional" rubble mound structure is probably the most practical and economic design. Present design procedures are, however, under review and the PIANC has set up a committee called the Waves Committee, which will publish in 1976 its findings on the design of rubble mound breakwaters, as well as vertical walls and composite breakwaters. So far, the findings of this committee may be summed up briefly as a definite need to improve, or rather to modify, the available design formulae which do not take into account the wave period. It has been well demonstrated by numerous tests and practical experience that wave period may be of major importance, since structures have collapsed under wave action less severe than that which they were designed to withstand, due to "resonance phenomena" between structure and wave action. Design formulae which do not consider wave period are therefore inadequate. It is also clear that breakwater geometry and the distribution of armour rock can be designed to be much more stable, and at the same time less expensive than by the present practice based on orthodox, entirely empirical rules and procedures.

Where it is difficult to get heavy armour rock, smaller rock may replace it, if it is "glued together" with asphalt mixtures. There are many examples of successful structures using rock asphalt, for example in Holland and Denmark. This can be valuable when low cost is an absolute necessity. Vertical walls - for example in the form of caissons, large blocks or piles - are not too common in the design of fishery harbours because they are usually too expensive, unless the harbour is located in a sheltered area. Some relatively inexpensive hollow pile or tube walls have been developed recently, for example by the Raymond Construction Co. in the U.S.A. These tubes, which may be 1 to 3 meters in diameter, are cast by rotation in sections 4 to 6 meters in length. They are provided with a great number of pipe-holes cast in the concrete, parallel to the axis of the tube. Cables are carried through the holes, making it possible to post-stress several tubes together to make up the required length. These tubes are jetted down (or may be dug down, using a grab inside the tube). Such pipe breakwaters have been built in Japan, South America and in places in Texas where wave action was moderate. They are usually filled with sand. On more exposed shores it may be necessary to place a rubble mound in front; in any case a bottom protective apron - for example a 1-2 feet thick layer of rock, is necessary in front of them, to protect against scour. A cap may be cast on top to provide a wave-screen against excessive overtopping.

Mr. Gifford also added a contribution to the reply:

I would like to comment on this question of wave characteristics. In effect, what has been said is that long-period waves cause accretion, while the short-period wave is the eroding wave. The first system is generally caused by distant storms; it is a long-fetch system and is not affected by local weather. The damaging, eroding wave is very often caused by the local weather system. Now the system likely to be dominant is normally determined, as we have been told, by obtaining the best meteorological records available and analysing these over the longest practicable period of time. We then use the vector diagrams derived from this analysis in designing works for the future. But recent reading and studies on this subject have shown that in fact there are indications of major changes in weather systems. This year, for example, anticyclones have been moving much further north across Europe than heretofore. The result has been that in Britain, for example, there has been a quite unusual weather system. In Spain and other parts of the Mediterranean the weather has been equally unusual. This is not a mere freak but is a pattern which is beginning to develop. There are indications from some meteorologists that this may mean a major change of weather systems, and this means that any analysis that we do based on past systems will be worse than useless for predicting the future. I am speaking about Northern Hemisphere situations, since most of the discussion today has been along those lines. If therefore one is planning for the Northern Hemisphere one should be extremely cautious when using meteorological data. Any proposal for harbour works which is dependent on narrow balances of wave direction for its success should be treated with great caution. Fortunately, most of the developing world is not faced with the sort of problem that we have chiefly been considering. Weather systems are different and, as a result of this, coastal characteristics are often quite different also. So perhaps those in the developing world can take heart from the knowledge that they will not have to deal with some of the difficulties that occur in Northern Europe. For example, Mr. Pilon has spoken of troublesome wave-cycles of 5 to 8 seconds. These do not occur in many parts of the world. Similarly, regarding boats thrown against dunes, it should be noted that throughout most of the tropical world there are no sand dunes at the back of beaches. Such dunes are a phenomenon of the north and south of the world. In the tropics, the back of the beach is normally wide open so that boats can be drawn up right over the back of the beach. Also, of course, an extreme storm is very rare, if not impossible, in many areas, so that this situation does not always arise.

Mr. Pilon: (supplemented by contributions from Professor Bruun and Mr. Gifford)

(ii) How should piling be dimensioned and spaced on an open work jetty or an open Sandy Beach in order to minimize the occurrence of accretion and erosion?
If piles are placed too close together they will cause erosion because the current is concentrated between the piles. The Dutch "piggy-back" groyne, with piles on top of very flat, smooth-shaped groynes, do not invite any erosion. As a Dutch engineer said 400 years ago, "water shall not be compelled by any force or it will return that force unto you". Examples of so-called permeable groynes can be seen in the U.S., in Jamaica Bay in Florida. They fail because they concentrate the current between the piles and set up erosion. In rivers they can work by slowing down currents and creating eddies and causing sediment to deposit.

As regards open piers, there are several hundred of these around the coast of Britain, built about the turn of the century, mainly as public amenities and to serve paddle steamers. They are usually very open structures, normally carried on cast iron columns of small diameter - less than 330 mm - mainly screw-piles. The effect that they have on the general regime is nil, because they are so open and therefore present so little obstruction to the waves. I am not sure what use such structures would be for fisheries in the developing world.

(iii) Regarding the use of asphalt in the Netherlands in the making of dykes, it was intended to use this in northern climates in the 1960's, but it was not known how the asphalt would react to ice, and so it was not used. Has any recent research been done, and has Mr. Pilon any figures of cost? Dykes built up of sand and asphalt are constructed for small harbours, where heavy wave action is not expected. There is one such harbour in the northern Netherlands where waves can be very high, though not as high as on the west coast. Greater thickness of asphalt is used today than in the early sixties, and the work is more specialised. It is possible to make the slope of the dyke very flat - 1 in 8, instead of 1 in 4 or 1 in 3. A further difficulty can be the growth of shellfish. In the tidal zone this can cause the loss of 1mm of asphalt in a year. We do not have much ice in the Netherlands but we did have heavy ice movement one year, and the asphalt dykes held up very well. Asphalt is a natural material; as in motorway pavements, a little movement of the asphalt is not bad. For heavier works we turn to large concrete blocks or rocks - though these must be imported. As I have said already, where low cost is necessary local materials are best. We have in the Netherlands sand, gravel and cement. In other countries other materials are possible.

(iv) For a tropical climate in places such as Madras, the temperature can be over 40°C for long periods. At low water levels and at such a temperature, would the asphalt melt and the breakwater disintegrate? Although there is white sand in Madras it is difficult to walk on the beach in summer, so one can imagine how hot it can be. Traffic can even seriously damage asphalt roads in these conditions.

Mr. Pilon: The temperature that you mention is quite high. If the air temperature is high and a black material is used, then difficulties must be expected. It is not a problem for us in the Netherlands, but some experiments have been carried out on the Netherlands coast using asphalt with a white filler, and this does not get so hot.

Professor Bruun: In some experimental work in Florida in the fifties we did have some problems; not the asphalt melting, but a change in the penetration of the asphalt, probably caused by ultraviolet light. It tended to deteriorate slightly - to crack. This problem has probably been solved by reinforcing the asphalt with steel or nylon. Nylon has been widely used in Holland. In many cases oyster shells have been used to produce a surface which is less absorbent of the sun. I do not know of any cases where high temperature as such has had a deteriorating effect. Asphalt has been considered again for the Suez Canal and for many other places.

5. SESSION IV

Mobile and Other Mechanical Structures for Use in Across-Beach Operations. Introduced by Mr. H.A. Dc

Mr. H.A. Delap

In this contribution I am dealing primarily with the machinery and equipment used in across-beach handling of fishing craft and the supporting or housing structures associated with such machinery. It is not proposed to go into the details of mechanical design but rather to offer a somewhat random collection of notes on some of the equipment and methods used in the beaching, hauling up and launching of boats, and the bringing of boats into safe shelter where they can lie afloat. These notes are intended to draw attention to some points which may not immediately occur to the designer of simple mechanical aids to such across-beach operations. A few of the points may seem very minor ones - but we are dealing, of course, with small-scale fisheries.

(i) Ramps or Slipways. The slipway is a very common and ancient method of bringing a boat to safety. The slip in its simplest form - or simplest but one, the simplest being a hard open beach - is an inclined plane, usually of concrete or masonry. At first sight there does not seem to be much more to be said about it. However, the slope is important. This is, of course, sometimes dictated by the slope of the beach or rocks on which it is founded. Generally, however, it is a matter of judgement, taking into account the weight of the boats to be handled, the labour that will be available, whether a winch or other tackle will be used to do the hauling. If the slip is too steep the work becomes very hard; too flat, and slipping may take too long, while a positive out-haul may have to be provided to pull the boat down the slip. Moreover, a flat slip is a long slip which, other things being equal is more costly to build. It is helpful, particularly if hauling is to be manual, to make the surface of the slip in the form of very shallow steps, with rounded noses. For example, a slip with a 10 % slope (1 in 10) might be formed of treads 450 mm width and vertical risers of 35 mm, the treads being given a fall of 10 mm towards the nose, to throw off water and so reduce weed growth. These steps make it much easier for people handling a boat to keep their footing and give them something to push from, if they have to provide the motive power. A neat and effective arrangement used in the West of Ireland in the past is to have a smooth slope up the central third of the slip, with the remaining third on each side formed in steps as described. However, a boat will slide equally easily up a flight of round-nosed steps.

In selecting a winch, judgement is again necessary in choosing a suitable gear-ratio for the slip-gradient and weight of boat to be hauled. The winch should, of course, be adequate for the loads to be expected but not so low-geared as to be unnecessarily slow in use. If a wide range of boats are likely to use the slip consideration should be given to a two-speed winch, but any additional complication will of course add to its cost.

Larger boats will need some form of cradle, mounted on rollers or wheels. Designs vary from the simple to the elaborate cradle with many wheels and axles. I would make a plea for simplicity - of design and operation - and sturdiness, which implies reliability and probably also means low cost. Elaborate gear calls for proper supervision and maintenance if it is to be relied upon to work whenever it is called upon, which will sometimes be in an emergency. This implies the need for some designated person who will be responsible for the equipment. Reference will be made to this person later.

A word of warning about slips with free-running cradles and winches; if the winch is rather under-powered for the boat being hauled up, so that a squad of, say, four men is required on the handles - two on each side - this can be a potentially dangerous situation. One man may ease up or even let go of his handle, adding to the load on the other three. They may be unable to hold on, and the load of boat and cradle takes control. A low-geared winch being driven by its load spins frighteningly fast and the virtually invisible handles can kill.

It may save money to remember that the most costly part of a slip is that part near and below low water, and that it may not be necessary to extend it so far, if beaching or launching at Low Water Springs are not customary at a particular site. The habits of the local fishermen should be studied. In the West of Ireland, for example, Low Water Springs occurs at or about midday, while the fishermen normally go to sea in the early morning and return in the evening. Boats may therefore never have to be launched or slipped at the lowest tides.

Placing a boat on a cradle can be a relatively simple operation in calm water, with good light and plenty of time. In failing light or total darkness, with a rough sea or a heavy swell and a queue of fishermen, aware of deteriorating weather and anxious to get their boats hauled quickly out of danger, it can be a very different matter. This is the fundamental disadvantage of all one-boat-at-a-time devices - slips, hoists, cranes, gantries; when the need for them is greatest the operation of them is most difficult.

At this point, when the demand on the equipment is at a maximum, a reliable and responsible individual in charge of the operation can, by being calm, efficient and impartial, as well as technically competent, stop a panic, restore order and effectiveness to the operation and save boats and perhaps lives.

As a means of coming ashore in difficult conditions an infinitely wide slip - that is to say, an open beach - has this one great advantage; its capacity is unlimited and each individual fisherman, with his crew if he has one, handles his own boat, if necessary at the same time as his fellow-fishermen. This suggests the desirability of having cradles designed to run on sand rather than on rails - or at least on skids that can be quickly laid down where these are required, as Mr. Gifford has described. In this way one achieves many of the advantages of the open beach landing while reducing the effort required to haul up the boat.

(ii) Cranes. Cranes or hoists are attractive to an engineer. They are the means by which he usually lifts things. Attachment of a heavy hook, or a complicated sling to a rolling or pitching boat - again perhaps in darkness or worsening sea conditions - without injury to the boat or the crew, makes the operation of a crane for this purpose a doubtful prospect. When planning such a system, and indeed when dealing with nearly every aspect of this problem of devising equipment for the handling of boats, the engineer must be also a practical ı, or must at least be closely associated with one.

(iii) Breakwaters. Breakwaters of various novel designs - that is, other than the normal static type - have been proposed many times. Floating, submersible, pneumatic or hydraulic breakwaters come within the definition of a Mobile Structure for use in across-beach operations and therefore within the subject matter of this contribution. It is too big a subject for a brief paper but might, I think, provide a useful subject for research. It is unlikely in my opinion that any non-static breakwater could provide, at a cost appropriate to small-scale fisheries, useful protection for boats or for the relatively vulnerable structures, such as dock gates, used by fishing boats. Problems of maintenance and of constant availability also raise doubts about the practicability of such solutions. Nevertheless, some research would at least provide reliable data that might avoid time-wasting investigations into similar devices aimed at providing low-cost shelter.

(iv) Booms. Mobile devices can sometimes be used to provide protection in another way. Basins used by small fishing boats, too small to provide adequate stilling of waves, and approached by quite a short channel, have been successfully protected at acceptable cost by removable booms - large logs dropped into slots to block the mouth of a basin. These logs, which can be handled by a hand-operated or small powered crane, are much cheaper than any form of one-piece gate, hinged or floated into position. They can be quite roughly shaped since they do not have to form a water-tight barrier; their purpose is to keep out waves, not water.

Such an arrangement must, however, be used with great caution. It must be sufficiently sheltered from direct wave action to be as safe as possible from damage by heavy seas. Some shelter is also necessary in order that closing of the boom can be delayed until the

conditions outside have deteriorated considerably. Otherwise it might become necessary to close the basin so early that boats seeking shelter could arrive too late to be allowed entry. This raises a very important point. It is essential that the provision of an enclosed - or enclosable - basin or dock shall not be allowed to create a false sense of security in the minds of the local fishing community. Its limitations must be stressed before it is built, in fact before a decision is taken to build it, and repeatedly after it has come into use. In Ireland 70 or 80 years ago, in a rising storm when many boats were already inside one such dock with the protective boom closed, a boat which had delayed leaving the fishing ground arrived at the dock approach and demanded to be admitted. After an argument the man in charge of the crane reluctantly agreed to lift the booms to let the boat in. The seas had increased rapidly and he found it impossible to close the boom again, with the result that all the boats inside, including the late-comers, were destroyed. The dock lay unused for many years after-

This story stresses the importance of another point - namely that the entrance to such a dock or basin, and in fact any channel that becomes dangerous in bad weather, should be so sited that a boat which arrives too late to be admitted at a boom, or too late to navigate a difficult entry channel, can withdraw safely to sea, and so have a chance of riding out the storm or finding shelter elsewhere.

The warning against creating a false feeling of security applies, of course, to any device or piece of equipment. Its limitations when used under adverse conditions must be repeatedly stressed and fully understood.

(v) Floating or land-based Dredging Plant. Floating dredging plant hardly comes within the subject matter of this paper, but I would like to refer briefly to some alternative methods of maintaining depth in channels and berths. Conventional dredgers are extremely expensive to build. Where the problem is to transfer material from one limited area to another it is worth considering the use of land-based plant. Professor Bruun has told us of old "Mudcat" dredgers in the U.S. passing a useful old age moored in the corner of some sheltered basin, pumping material to create an artificial breakwater within pumping distance. A suction pump, or a dragline or other type of excavator, can be mounted on land, perhaps on rails to permit it to be moved out along a pier to bring it within reach of an area where material accumulates, or where a catch-pit can be dug to trap migrating drift material. These rails might be laid on an existing pier, which can if necessary be extended in the form of an openwork gantry. The moving plant can then be withdrawn to shelter in bad weather - but can probably work in conditions when it would be unsafe to use a floating dredger close to a pier-head or to shallow water. If the plant is in the form of a pump it can be accompanied by a mobile crane, probably mounted on the trolley carrying the pump itself, which may be used to place the suction-head of the pump in the required location.

A harbour entrance in Ireland was kept open, when no convenional dredger was available, by using the two main winches of a dragline excavator, in conjunction with a "deadman" sheave anchored to seaward, to haul a scraper bucket back and forward across a gravel bank. The accumulated material on the bank was thus transferred to deeper water, whence it was carried across the harbour mouth by tidal currents. The gravel bank was thus prevented from building up and encroaching on the adjacent navigation channel. In bad weather, when seas swept over the piers forming the harbour entrance, the winches and their ancillary equipment, which consisted simply of a conventional dragline without its jib, retreated to shelter at the root of the pier, travelling on its crawler tracks. This was an experimental set-up, which unfortunately had to be dismantled - for reasons unconnected with the experiment - before reliable figures of cost could be obtained; results were, however, promising. I believe that for exposed sites, such as a harbour mouth, the initial and running costs of plant of this type - even including additional supporting structures if such were necessary - would compare favourably with the cost of conventional floating dredging plant. This would seem to be a promising field for further experiment.

The Chairman thanked Mr. Delap for his presentation, which he knew was based on his very wide experience of providing facilities for the smaller boat fishermen. He was certain there would be a number of interesting comments and questions and, from the manner in which discussions had developed in previous sessions, he considered that an open discussion might be the most suitable method of dealing with them. He therefore called on speakers, who contributed as follows:

Mr. Moor: In Peru some thought has been given to both slips and breakwaters. Problems can arise with slips, and in fact with any fixed structure, on sandy beaches with heavy littoral drift, where erosion or accretion is possible. On one site in Peru erosion is of the order of 30, 40 or 50 meters. As to floating breakwaters, their efficiency depends very much on the relation between their width and the length of the approaching waves. In Peru with a predominant wave of 14 seconds period, a very wide floating breakwater would be required. There are one or two places, bays, where for part of the year there is a local wind, generating local waves, where a floating breakwater might be possible, but where across-beach landings exist the long-period waves and heavy littoral drift also exist, and so neither slips nor floating breakwaters can be used.

Mr. Gifford: The question of the independence of winches is a very important point. We have made some observations at Hastings, which is a very old fishing community, probably representing a thousand years of beach-landing operations. It is an extremely closed community, related by marriage and in every other way. Yet though everyone is related to everyone else, every boat is completely independent of its neighbour, with its own winch, its own skids - or trows as they are called there - and its own winch-operator, who is known as "the boy ashore". The boy, who is usually about 70 years old, does nothing except serve the winch; he appears when the boat is due to come ashore and is ready with a line. Therefore, I think it is very important, when we are thinking about these operations, planning to set up new communities or to introduce new ideas to communities that have used different methods, that we should recognise the independence of the fisherman, and the need for him to take his own seamanlike decisions, in his own time, not dependent on any sort of cooperative effort. Cooperation will grow under certain circumstances, but not if imposed from outside.

We have all studied floating breakwaters hopefully. To get a useful reduction of wave-height, say a 50 % reduction, with a wave-period such as Mr. Moor has referred to, 14-15 seconds, it would appear that a structure (even if only a spatial structure) extending over a width of probably 100 meters - possibly a good deal more - is required. This will still take only about 50 % from the wave-height, which will still leave a large enough wave to embarrass the small boats that we have in mind, operating from a beach. I feel therefore that while a floating breakwater system may be suitable for the protection of oil rigs, where the expenditure of millions of pounds per annum for the maintenance of the system may be an economic possibility, it is probably not a practical proposition for the man we are concerned with here.

Professor Bruun: Mr. Delap has pointed out some of the most important problems arising in landing operations on an open shore exposed to rapidly developing storms. Under such conditions boats cannot easily wait in a queue to be handled by a more or less complicated landing facility. They must either land on the beach or go to a sheltered area or to a harbour. This again raises the question; is it possible to use less expensive types of breakwater? In this respect I would like to add a few comments to what I have already given on Mr. Pilon's paper. Rubble mounds can now be designed more rationally and more cheaply than in the past. Pile structures of newly-developed design are a possibility where wave action is not too severe. They must be located outside the breaker zone, and should be placed with a relatively small spacing, to cut down wave action to the desired level (Reference No. 4), or as a completely solid piled wall, the layout and design being adjusted to the local conditions of wave, climate and littoral drift.

The "skirt" wall, i.e., widely spaced piles with slabs in between, is suitable where the $\frac{d}{L}$ (Depth/Wave-length) ratio is relatively high - i.e. short waves in relatively deep water. By short waves is meant waves of 4 to 6 seconds period (depending on depth). For low $\frac{d}{L}$ ratios (that is, shallow water and translatory waves) the skirt must extend to 2/3 to 3/4 of the depth in order to have any appreciable effect. Numerous tests on single- and double-skirt walls have been undertaken in Japan, the U.S. and Norway. They are mainly useful in protecting areas such as fjiords and bays from local and not ocean waves. The limited bottom support provided by a few piles as well as the possibility of bottom scour present problems.

The use of floating breakwaters has been mentioned several times. A number of patented types exist - e.g., the Hassler and the Harris. The only type which has proved useful,however (at least for medium conditions), is the box type, particularly investigated in Japan and Norway. The width of the box, a concrete or steel pontoon, must be at least 1/4 of the wave-length. The design becomes uneconomical for waves greater than 6 seconds period, unless one or more old tankers or other long vessels can be secured for the project. Barges connected together by cross-members is another "structural" solution. All other breakwaters of the floating type do not seem very practical or useful for waves of the ocean type. The recently advocated anchored buoys or a matrix of tyre types would require much maintenance and would have to be very wide. Anyone acquainted with the difficulties involved in the mooring of buoys has great doubts about their practical applicability.

For exposed shores I think that we must rely on either some form of transfer system for conveying boats across the beach, or we may use an open pier to by-pass the littoral drift problem; such installations will not be available for use during the whole year - certainly not in India.

Mr. Delap has also referred to the use of dredgers. Dredgers excavate holes, but they also produce the fill. Breakwaters have been built in this way. In the harbour of Thorsminde on the Danish North Sea Coast, breakwaters were built by waiting until a large sand-wave travelled along the shore, and then placing material on top of what sand-wave. In this way half the fill was saved. Burns harbour, Lake Michigan, in Indiana, one of the largest American ports in inland waters, is subject to waves that may exceed 16 or 17 feet. The middle part of the breakwaters were built up, during the summer, by dredging, to form a very large sand core.

As to special pumping devices, a very simple and powerful pump has been developed in the U.S. - a 10-inch pump which can be operated from a trawler, with the power generator on the shore. It can pump a few thousand cubic meters per day. Inexpensive breakwaters can be made in this way. The small pipeline dredger called "Mudcat" can be used for the same purpose.

If we are to advise the developing countries on methods suitable for small-scale fisheries, these works must be inexpensive. We must look for new ideas but we can also use experience that is already available, maybe even for a long time. By improving existing design and construction techniques we can arrive at designs and structures which are much more economical.

Mr.Guckian: To restate the basic problem encountered throughout the world, the small-scale fishery may be based on the one-man canoe, which comes in through the surf into perhaps 20 cms of water, probably upside down for the last 20 meters. The crew member jumps out, holds his catch in one hand and his boat in the other and walks up the beach. This method works, but it does not produce much fish. The next stage is the slightly bigger boat, say 10-15 meters long, with 10 or more paddles, such as is used in Senegal, Guinea, Mauretania. They are rather more

sophisticated, but the crew get very wet, and it may take several attempts to get out through the surf in safety. It may be possible to help them with structures, such as a slipway as described by Mr. Delap or a simple breakwater structure which gives a reduction of 20 % in wave-height. These improvements may be sufficient in certain cases or at certain times of the year - so long as the breakwater is not washed away during the remainder of the year. If, however, the aim is to bring in a sophisticated fishing vessel, with an engine, an echo-sounder and a winch on board, one is facing a very different problem, and it is here that this Conference may be able to provide some solutions - perhaps a structure to lift the boat out of the water prior to the commencement of storm conditions. I agree with both Mr. Gifford and Professor Bruun that we must always think in terms of low-cost solutions, that is, low cost in provision, low cost and simplicity in operation and low cost in maintenance.

Mr. Gifford: I would like to make a further comment on Professor Bruun's remarks and put forward a proposal for a modification of the breakwater that he described. With the piles (which can be of any kind - concrete, timber or steel) spaced sufficiently far apart, perhaps 8 or 10 meters, so that in the critical zone for the transport of drift material there is in effect an open jetty offering virtually no interferenoc to littoral drift. In the zone at water-level where we want to subdue waves there is a wave-breaker, consisting of vertical elements, which can be dismountable. I have used such a wave-breaker and I know that it works with waves of 1-2 meters, where practically no wave appears on the lee side. Clearly, in extreme weather conditions, such as the North Sea, such a device would not survive more than perhaps one winter. But in certain areas that we are considering, on tropical coasts, the extreme storm is such a rarity as to be virtually non-existent. So such a device might perhaps work.

Mr. Breimer: Commenting on Mr. Gifford's suggestion, which is perhaps more relevant to Mr. Pilon's paper than to Mr. Delap's contribution, although there is very little difference between a fixed or floating wave screen. In Goteborg in the mid-forties, finger piers were constructed in the river to accommodate small naval vessels. Big ships travelling at speed set up waves of up to 1 meter in height which were damaging these structures. It was not easy to provide a breakwater since there was about 6 meters of water with 20-25 meters of soft clay below, over the rock. Only limited money was available. We drove piles at 30 meters centres, with a concrete beam connecting the pile-heads. Pre-cast concrete slabs were made which were taken out by crane and hung from this capping beam. These screens were erected in 1948 and are still effective. I believe that they reduce the wave height by about 70 %. The slabs extend down about 2.5 to 3 meters from water-level. It was not a very cheap arrangement because of the bottom conditions with a need for long piles.

Professor Bruun: We are dealing with vertical structures and considering how to absorb wave energy. There are two ways of doing this; by absorbing or by rejecting the energy by reflection. For an inexpensive design, we must use as little sophisticated material as possible. Mr. Breimer's design is perhaps a little sophisticated, though there is no doubt that it works in the Goteborg conditions.

As to Mr. Gifford's proposal, it is in effect the "skirt principle". With D as the depth of the skirt, and if the skirt is carried down to a depth of .8, that is to within 20 % of the bottom. The reduction in wave energy can be read from a simple graph. In order to make a worthwhile reduction in the energy of a shallow-water wave (not necessarily a translatory wave but a wave where the depth of water is about one tenth of the wave-length), the skirt must go down to .8 of the depth. At .5 very little reduction is obtained. With deep-water waves there will be much more absorption of energy required.

Many tests have been made with skirt walls. Some of these are constructed as double walls, the width of the structure having a certain relationship to the wave-length. So we are combining translation and reflection, to such an extent that what emerges is quite a small proportion of the energy. It is still necessary, however, to have a width of not less than about 1/8th of the wave-length, which is quite feasible. With two lines of piles and two skirts the design becomes a little involved and it is perhaps not suitable for open shores but for protected shores. The only structure suitable for an open shore is the piled wall, referred to by Mr. Gifford. Here the spacing of the piles, and the relation between pile diameter and pile spacing, is all-important in determining how much reflection will be obtained. The aim is to reflect as much energy as practicable, but the greater the reflection the greater the horizontal load on the structure, so a balance has to be struck. The theory has been developed, the tests run and a formula worked out, which gives reflection coefficients and translation coefficients for waves acting on a piled wall. With regard to the forces on the piles, these are shear forces only and depend on the water velocity and a certain drag coefficient, lying between 1/2 and 1. This has been tested very thoroughly in recent years with the North Sea oil platforms and is therefore based on experience. So it is quite possible to arrive at an economical design for a piled wall if foundation conditions are good.

We have spoken of littoral drift. We have to live with this. It does not always matter if a tombolo forms inside; this can be a nice feature, giving a wide beach. It is important to try to avoid back scour. This may happen with a severe storm when waves approach the shore from a particular angle. One may have to live with this also, though it may be possible to make the breakwater long enough to reduce greatly the probability of scour. This is a matter that has not been studied in detail; when enough research has been done on the relations between wave motion, depth and distance from shore it should be possible to arrive at almost a standard design for this type of installation.

Mr. Gustafsson (Indian Ocean Programme, FAO): In fact we are discussing the means of transferring of fish from the fishing vessel to the market. It is necessary to distinguish between conditions in the tropics and in other climates. In the tropical waters of the Indian Ocean, where the water temperature is about 30° and the air temperature is high, the spoilage of fish is an enormously important factor. The time that a boat can remain at sea is limited unless you have ice or some alternative means of storage. But we do not as yet have ice everywhere; there must be other solutions. It may be necessary to salt the fish on board, perhaps cook it. In fact, it is quite common in tropical areas to cook fish on board, for further drying ashore. The large deck of a catamaran is therefore an advantage; it is a factory-ship in miniature, where you can do things that are not possible on smaller vessels - fish can be boiled or smoked or dried at sea. The possibilities of the catamaran are quite exciting. However, I wonder if it needs to be made up of two standard hulls? About 30 years ago I built a catamaran, using two cylinders on each side, of expanded polystyrene foam in a very thin aluminium shell. This sailed very well. Unfortunately the aluminium did not last for ever. But looking at Mr. Gifford's design; perhaps cylinders could be used. It may not be necessary to have the engines down in the hull. It may be possible to store the fish in containers on the deck, where it is easy to clean and keep tidy. We can think of the deck as a square area, a floating raft with a cylinder on each side. This can then land on the beach sideways-on and be rolled up, using the cylinders as rollers. This is just an idea, not a solution.

The cost of energy is almost killing mechanized fishing today. As I have said, a catamaran sails very well. Why not put up a sail - you have a mast and a boom already - and use the engine when there is no wind or when trawling, with the sail in addition?

Mr. Guckian was concerned about the employment factor if more efficient methods are introduced. Certainly this is a difficulty; if the same number of people is to be employed a much greater quantity of fish must be caught. That would be the ideal, but I think that we must compromise. There is a shortage of food, of protein, in the world. Even if the same number cannot be employed, more efficient methods can be justified by larger catches. But it is not enough to catch the fish; it must be at a price that the poor and needy can afford.

Mr.Gifford: May I respond quickly to Mr. Gustafsson? The suggestion that the fish should be carried in containers on deck is interesting and this is possible - an advantage of the catamaran is, of course, that it has sufficient stability to be able to carry loads high up. As to hull shape, we were anxious to keep the draft as small as possible, and this means hulls with a flat bottom, to minimise draft for a given load-carrying capacity. Cylindrical hulls will do further out at sea. As to rolling up the beach on the cylinders, this is another problem, and I would like to take the problems one at a time!

Reverting to Professor Bruun's remarks about the method of wave-reduction which he names the "skirt" system, I would like to know if the figures he mentioned for limits of depth and wave reduction efficiency are based on calculation, on small-scale tests (of which he has said that he is rather sceptical) or on full-sized tests. I have had experience of building one of these structures, which worked remarkably well, though on waves of only 1½ meters. It seems to me that even if the reduction were a good deal less than the 70 % mentioned, it would not be necessary to carry the skirt down to 90 % of the depth of water in order to achieve a very useful reduction. And one would be completely free of worries about littoral drift which I think is very important, since there are many situations in which we cannot afford to ignore littoral drift.

Professor Bruun: The effectiveness of the skirt wall depends upon the character of the waves, whether they are deep-water waves or shallow-water, or translatory waves - that is, waves just before breaking. On exposed sea coasts we are dealing with shallow-water waves, close to translatory waves, where the wave motion extends all the way to the bottom, and where the wave-height is approximately ½ to 2/3 of the water depth. In these conditions the skirt system does not work very well, simply because there is a current of water passing through which creates another wave behind the skirt. In these conditions the skirt must go down close to the bottom - say to 80 % of the depth. So, in relatively protected areas, where the wave action is small, the wave-length not too long and the wave-height not too great, the system will certainly work. It depends entirely upon the ratio of depth to wave-length. In full-scale tests many years ago in the Black Sea skirts were put down below 70 % of the depth to obtain a reduction of about 50 % in wave-height. Many results of model tests and full-scale tests are certainly available.

Mr. van Steenwijk: I would like to refer to the large oil storage structure in the Ekofisk Field in the North Sea, which is a French conception. I believe that this has a skirt with horizontal holes in it. Would Professor Bruun comment on the reduction factor which this provides? As far as I know, the design conditions were; wave period 16 seconds, wave height 30 meters, wave length 300 meters.

Professor Bruun: The Doris tank, for the Phillips Oil Co., was designed more than three years ago. The design wave for that site was 20 meters, the design period about 13-15 seconds. The tank has a diameter of 92 meters and a height of 90 meters. The holes in the lower section are 90 cm and in the upper section 1.35 meters. The following facts have now been released - they were confidential until recently. The skirt wall was put around the tank because it was believed that it would decrease the horizontal forces on the tank. This can only be done by avoiding full clapotis effect on the wall, and secondly by absorbing some wave pressure

on the first wall and then, one or two seconds later, on the second. Instead of having one large peak it absorbs two smaller peaks. The interior wall of the Doris tank has a diameter of 50 meters, the space between being 21 meters. Tests were run on the tank for 14 months. The total force on the inner tank, without the protective wall around it, is smaller than it is on the structure with the skirt around it. Another reason for the outer wall was to support the deck on top of the tank, but a very important fact emerged from our tests, the great danger of breaking waves to these structures in the North Sea. The resulting shock pressures and repeated high pressures may, with the soil conditions present, produce problems of liquifaction at the bottom which may endanger the stability of the whole structure. This could happen very rapidly, in a matter of 1/10 or 1/5 of a second, causing cracking in the wall. Cracks could develop very quickly in a North Sea storm, which can last 50-100 hours, or even longer, making urgent repairs impossible. If cracks caused by shock pressures occur in these walls oil will leak out. It was therefore necessary to put in the perforated wall, to avoid shock pressures. The wall is pre-stressed and post-stressed with Freyssinet cables so that all tension is avoided. As to reflection, it is a round structure so that the reflection could be calculated; it was between 30 and 50 %, depending upon the character of the waves - mainly on the wave-length but to some extent on wave height also. Two further Doris-type tanks are to be built in the North Sea as production platforms, with a somewhat different configuration, a rather wide base and a shaft (perforated) rising from this base. The forces on the tank are of the order of 100 000 tons horizontal and 30 000 tons vertical. These high pressures also raise the problem of pore pressure in the sand bottom. The bottom is flexible and with certain storms, with waves of 12, 13, up to 17 secs. period (the 15 sec. wave is more dangerous than the 14 or 16 sec. wave), pore-pressure may develop, so that the tank is no longer resting on the soil but is carried by the pore-pressure and may become laterally unstable. The tanks now being built have skirt walls, designed to penetrate deeply. There is another serious problem with these North Sea structures: if they are too long (water depth > 250 m) they may be in resonance with part of the wave spectrum. That is why the highest wave is not the most dangerous, unless it has a period of 4-7 secs. At that point the structure may begin to oscillate due to the wave action, pore-pressure developing very rapidly, which may be fatal. Again, the structures now being made with skirt walls penetrating 4-6 meters present another problem when they are being placed; the natural period of the floating structure may be in resonance with wave action. So some heavy steel dowels, 2 m in diameter, are set in the bottom to absorb forces by oscillation. The result is that the skirt comes down slowly in the bottom. Another problem arose when the Doris platform was being placed. It was to be located within a variance of 1 meter. When it was about a meter off the bottom the whole structure slid sideways about 50 meters; this was due to a phenomenon which we call wave-drift. We cannot control such a situation, the forces are enormous - even 4 or 5 tugs can do nothing. So if a completely level bottom is necessary you have to accept that the structure cannot be placed with an accuracy of less than 100 meters or so.

All these problems with structures in the North Sea may seem out of context to this Consultation, but they are valid for the development of any sea structures generally. We can build better and more economical breakwaters based on new design principles not on the old-fashioned empirical formulae.

Mr. Breimer: With reference to lifting arrangements for bringing boats or cargo ashore, there is an existing teleferique in Sidi Ifni, the old Spanish enclave on the coast of Morocco. This is on the open Atlantic coast. The equipment was supplied by a French firm in the early sixties. It is 1 300 meters long, with an 80 mm cable supported by two towers and a station ashore. There is a cable car which can take 20 passengers and a further 10 tons can be hung underneath. Ships from

Spain lay alongside the platform, which is 50 meters long by 20 meters wide and has living accommodation and two derrick cranes to take cargo from the ships. The car takes about 20 minutes to travel in to the shore. It is no longer used for imports or exports, but by the local fishing village; the boats are lifted out of the water by the cranes and carried on the roof of the car. The fishermen travel in the car with their catch. There are two cables so that two cars can be operated at the same time. A capacity of 10 tons would be unnecessary for a fishing village but a workable arrangement, capable of reaching out beyond the breakers might cost more than 5 million dollars.

Mr. Moor (Netherlands): With regard to Mr. Delap's contribution, I will describe the system used at present in Peru. The vessel beaches on its own and once it is on the beach, a wire is passed around the upper part of the hull and a tractor hauls it out. This is fairly satisfactory; it would be improved by fitting steel strips on the keel with a short length of wire which would be attached to the main hauling wire. Launching is more difficult, and has to be done by hand. One improvement which is being considered would be to fit the tractor with a boom, say about 8 meters in length, to give the vessel a last-minute push so as to free it from the bottom.

Mr. Guckian: Such an arrangement as described by Mr. Moor is actually done by oxen in Portugal, (a photograph of which was circulated to the participants).

Mr. McGrath (Ireland): Mr. Delap referred to the importance of not doing anything that would tend to create a false sense of security in the minds of fishermen. I feel that this cannot be stressed too often. We have experience in Ireland of many demands by fishermen for works which they believe to be of comparatively low cost and of apparent value under certain circumstances, but which have to be rejected because of their inherent dangers under different conditions.

Mr. Bhakta (India): At Cuddalore, on the East coast of India, two rivers meet at the entrance There is a bar at the mouth. The available depth over the bar is about 3 feet (1 meter). Central Water and Power Research Station, Poona, suggested training these rivers and building a finger pier, on piles, with a pair of pumps handled by a mobile crane which can move along the pier. There is littoral drift in both directions on this coast; the predominant drift is south to north and occurs with the south-west Monsoon. The estimated annual drift in this direction is of the order of 1.5 to 2 million tons. In the other direction the quantity is about 0.25 million tons. So any structure causes erosion on the north side and accretion on the south side. The scheme proposed is to use the mobile pump to transfer drift material from south to north of the channel by keeping the channel dredged to about 6-9 feet (1.8-2.7 m) deep where it accumulates. During the season when the direction of the drift is changed, the open space between piles of the jetty is closed by placing planks called needle shutters between the piles, so that material does not enter the channel, but accumulates outside while the pump continues to dredge a deeper channel. The width of the channel is about 10-15 meters; the pump is moved along the jetty with a boom of about 18 meters long to dredge the channel.

Mr. Wong Kim Yok (Malaysia): Mr. Bhakta's solution for one of his river estuaries is very interesting. We have many small fisheries spread along our coasts, so that we need a solution that can be applied in many places without enormous capital cost. What are the capital and maintenance costs of the solution?

Mr. Bhakta: The capital cost, in India, is about 300 000 dollars.

6. SESSION V

Consideration of Specific Projects Submitted

(a) Mr. Bhakta's Proposal for a Transfer Jetty for Small Mechanised Fishing Craft

Mr. Bhakta (India) introduced the proposal described in Annex IVg.

I do not suggest that this scheme will solve all problems or suit every country, but I feel that it can solve some of the problems that we face in India. Our first problem is that we have cyclones. We have difficult coastal conditions, which may occur in other countries, which make the operation of small mechanized boats hazardous. I would stress the word "operation", which is intended to include not only the landing and launching of vessels but also caters for shelter and repair facilities. Even if a sophisticated landing facility is provided, the fishermen are unlikely to use it if there are no shelter facilities. It would be far less expensive to provide facilities for landing and berthing, in fair weather, along most of the coast, than to provide shelter and repair facilities for small mechanized boats. Along the East coast of India, in particular, there are long stretches of coastline without any sheltered bay or estuary. So the operation of small mechanised vessels, with a total at sea range of at most 40-50 km, is very difficult; they require sheltered harbours every 30-40 km, and these cannot be provided at an economic cost. Moreover, particularly on the east coast we have cyclones almost every alternate year. It is therefore very hazardous to leave boats at anchor so they must be protected. There are some big river estuaries, but large rivers have heavy floods during the monsoon period and boats cannot be kept in them safely, while the smaller creeks are closed for most of the year - and even when they are open the depth over the bar of the mouth is inadequate for small vessels to enter.

It will be understood that a developing country, with a coastline of about 4 000 km, would have great difficulty in providing fishing harbours every 30-40 km for small mechanized boats, of which there are about 10 000. There are nearly 200 000 indigenous boats, for which we can provide no facilities. Consequently the poorer class of fisherman with a small mechanised boat suffers from lack of facilities and from operational difficulties. He may not need a sophisticated facility for landing fish or for berthing his boat - his primary need is basic facilities for attending to small repairs, so that he does not lose many fishing days through having to go to another port for repairs or other needs, and shelter for his boat in bad weather. Therefore the facility should be designed to function as a landing and mooring facility in fair weather, and also enable protection to be obtained for his boat in bad weather, and repair facilities whenever required. This facility should be strong enough to withstand stormy weather and wave action during cyclones, and at the same time be simple enough to be operated by some form of cooperative organized by the fishermen, without much expenditure or dependence on Government funds.

There is a problem, particularly on the East coast of India, that if a structure has a deck, then the whole structure has to be designed to withstand cyclonic waves, which makes it very costly. There is such a jetty, in Pondicherry, for handling commercial cargo, the deck of which had to be kept 5 meters above high water level, and the whole structure is made very strong. Now operation is found to be difficult, because of the height. Cranes and trolleys have been provided but it is not very popular. The problem in designing the deck is therefore that it has to be open, to allow wave energy to be dissipated, and at the same time it must be possible to handle boats, and if possible also provide some shelter. Most of the thought given to this problem has been towards changes in boat design, and this would no doubt help the mechanised fishermen. But what of the existing small mechanised boats 200 000 canoes and catamarans already operating? Every fishing family depends on such boats. It would be difficult for them to change over to a new type of mechanised boats. So I concluded that the best solution is to bridge the gap by means of a boat transfer jetty. I hope that this will answer some of the problems. In particular, it will handle the existing types of mechanised boats and therefore the fisherman will not have to change his fishing vessel. Secondly, it will also handle the indigenous boats or the larger beach landing boats, enabling them to cross the surge zone quickly, both when launching and returning to shore.

A third advantage is that if any accretion takes place there is plenty of room to dredge between the piles, using a grab dredger or similar plant moving on the rails of the jetty, to provide the necessary depth alongside the jetty. Fourthly, if accretion becomes too great the jetty can be extended by adding a further bay at the head.

Professor Bruun:

I have two comments to make on Mr. Bhakta's proposal. Boats will approach the structure bow-first, and I think it is his intention that there should be sufficient fendering to protect the structure from blows from boats which do not reverse in time. Secondly, as regards the spacing of the piles. This is a matter of economy, and of what equipment the contractor has. But the shape of the piles is very important. The force due to wave action on a square pile is 2 1/2 times higher than that on a round pile. The round pile has to withstand a much lower shear stress and is therefore more economical. The possibility of scour is also much greater with a square pile, although this may be an advantage by encouraging material to pass through. But round piles are to be preferred. I have seen square piles, H-beams, used as wave poles, which have collapsed, where a round pile of smaller dimension would survive.

The following questions were asked by the participants named:

Mr. Breimer: (i) Have estimates of the cost of the structure been prepared? Am I correct in thinking that no provision is made in the prototype for mechanization or for installation of electricity? Have any calculations been made about the time required to put one vessel ashore; and how many boats can be handled in a day? Finally, have estimates been made of the annual cost of maintaining the equipment? I am always a little concerned where mobile equipment, steel structures and such things are associated with the sea.

Mr. Gifford: (ii) I have two questions. Is the deck of the jetty removable? The operation is stated to have a 15-minute cycle. This means that with 20-30 boats it will take up to six hours to launch the fleet and six hours to get the boats in again. Is this acceptable? Most fishermen in my experience want to go out all together. In this case it will be necessary to spread fishing time.

Mr. van Steenwijk: (iii) I read in your statement that the function of the boat transfer jetty is not to transfer mechanized boats up to 10 meters in length, and indigenous boats, from beyond the surf zone a few hours before impending foul weather or a cyclone, as an alternative to a sheltered harbour. As Mr. Delap pointed out yesterday, the best fishermen will stay out as long as possible, and there may well be a crowded situation when they all come in. I have observed also that bad weather at sea will often show itself first as high waves, because long waves run fast. And so, when the fishermen turn for home because they feel that bad weather is coming, the situation at the jetty due to these waves is already very bad. And so you have a bad situation just when you want to lift boats out of the water. Do you think that this is a problem?

Mr. Guckian: (iv) Despite what Professor Bruun has said regarding pile diameters, the average square or hexagonal pile is made in every contractor's yard. We are comparing this smaller pile with a 1/2-meter to 1 meter tube pile, spun or solid, which is quite heavy and requires different, and heavier plant. It is easier to handle and drive the normal square pile. Driving the heavier pile from floating plant in the breaker zone would be extremely difficult, and very hazardous. How is it proposed to drive these piles?

Will it not be a problem to get the boats, approaching from the sea, into the gap or bay at the end of the jetty - an opening of perhaps 5 meters or less - even in a swell or an unbroken wave? Some sites will no doubt be more difficult than others. This, of course, is really a question for fishermen rather than engineers, but this is no excuse for the engineer, he must ascertain the facts.

Mr. McGrath (Ireland): What provision is made to ensure overall supervision and traffic control of the facility, and to guard against damage to boats while using the installation. What provision is made by way of insurance cover to compensate for damage caused to vessels?
(v)

Mr. Moor (Peru/Netherlands): I cannot see how the jetty will be constructed, nor how floating plant can be used in the breaker zone. Construction will have to be done from overhead, from one bay out to the next, and for this a twelve-meter span is excessive.
(vi)

Mr. Gifford: I am not quite clear about the function of the jetty. Is it intended that the boats will normally use the beach, the surf being insufficient for the greater part of the year to prevent this? Or will the catch be loaded normally at the end of the jetty, the boats then being mooring off? In the latter case the catch would presumably be taken ashore on the trolley, since there is no deck. If the jetty and trolley is only to be used for getting the boats up in an emergency, why cannot they be hauled up on the beach, before the storm gets up?
(vii)

Mr. Bhakta gave the following replies:

(i) An estimate has been provided. We have consulted organizations that have been doing piling work of this kind. Mobilization of plant is a very large item - up to Rs.100 000 (with about 8 Rs. to US $ 1.00). The prototype is hand-operated, but a crane and other equipment can always be added. Electricity can be used. I have calculated that about 10-15 minutes will be required to handle a boat, depending upon weather. So we consider that about 20-30 boats can be handled in a 6-hour period. I have made an estimate of the cost of maintenance. If it is hand-operated no crane operator is needed - only greasing, painting, etc., - and the fishermens association can look after these things. Once a crane is provided we must have a crane operator and this, with electricity charges and maintenance, will come to about 1 lakh (100 000) of rupees.

(ii) The jetty has no deck. It is not, however, operational in bad weather, but it does allow the fishermen to take advantage of brief spells of good weather if they wish. Often boats in a harbour are not allowed to go out in such circumstances. The rate of operation is acceptable. The fishermen have had no facilities before. Also, the launching and landing is only necessary during the monsoon season. It is only when there is a cyclone warning, for example, that the boats have to come in. At other times they can moor to a buoy, or to the jetty itself.

(iii) This jetty is like a harbour. This can happen in a harbour where a channel is narrow; if many boats come at the same time they will choke the channel, and there are occasions when this can happen. A case was quoted yesterday of one boat causing the loss of a whole fleet inside a basin protected by booms. The present position on the east coast of India is that the fishermen cannot operate mechanized vessels at all. The boat transfer jetty will facilitate this in a limited number of sites and once they realize its limitations I think that the fishermen will be wise and come in in good time. We must expect that. In addition, we have a system of storm warning signals, to warn that a storm is likely to approach within 10 to 12 hours. Most of the fishermen can see these signals from about 5 or 6 miles (8-10 kms) out to sea.

(iv) Before suggesting these piles I confirmed that there is a contractor with the necessary equipment for making and handling the piles. They have been driving them at 8-10 meters centres and can probably do so at 12 meters if required to do this on a large scale. As to Mr. Cuckian's comment about the difficulty of operation, a number of captains and navigators of large ships who were consulted said it was not possible. However, about 150-200 small mechanized boat operators and fishermen who were consulted said it was quite possible.

(v) Indian fishermen are no more careful or intelligent than any others. But most villages have a fishermen's cooperative organisation and this can take the responsibility of the installation. It would be impossible for the state government to have an organisation at every small fishing base. The cooperatives are always there and they can appoint one member to look after the installation. Most of the structures are maintenance-free, being of concrete. Iron has to be cleaned and painted at regular intervals of time. I do not see any serious difficulty.

(vi) For construction, a temporary pile is driven between the permanent bents, and a piling platform is carried on this.

(vii) The fish can be landed and handled by the crane itself. There is a walkway, and the boats can come alongside this. If there are only one or two boats their catch, say half a ton, can be brought ashore by head-load. If there are 5 or 6 boats the catch can be handled and transferred ashore by the crane. The boats need not come to the beach every time, but can moor to the jetty or to a buoy. The fishermen can go ashore and return by the walkway.

The following general comments and statements were also made:

Professor Bruun

We have been speaking of maximum waves. In the sea we have only a wave spectrum. We know the pattern very well - in a place such as Ramayapatnam, probably 10 000 observations were made. For operational purposes it is not the single wave that is the dangerous one; if I see two or three large waves coming in succession, I simply do nothing until they have passed. In this connection statistics have been developed, mainly in Japan by Dr. Goda, while in the last three or four years we also have developed statistics from which we know the distribution of waves quite well - the probability that a very high wave will be followed by a wave of the same height - and that two high waves of the same height will recur after a certain interval. There is some truth in the saying that the seventh wave is the big one. In designing these structures, one provides the allowable strength for normal storm conditions, and the ultimate strength for the very extreme conditions. When considering operation of the jetty one simply looks at the wave spectrum, from which one obtains the answer to the question - how often can the facility be used during a year?

Mr. Bhakta

We have the data and can determine this. We also want to know what is the probability of being able to use the facility within the next few minutes? Then one must simply wait. I agree that one should provide some safety factors, such as buoys or anchors on which to winch oneself in, and perhaps some training walls and the like. On some piers rotating fenders have been tried; these are rather sophisticated, but an old tyre, rotating on something, can always be used.

Mr. Delap

This is a very interesting project. On the question of maintenance, Mr. Bhakta feels, I think, that it would not be necessary to have any one person responsible for maintenance of the structure and machinery; that it is simple and that there is nothing to go wrong. While nothing may wear out, there are a number of winches with wire ropes, and the latter tend to be neglected and left unwound and subject to damage. I think that one person should be responsible for going over the equipment and seeing, for example, that the winches are wound up and the wires properly stowed, otherwise they will very soon be damaged or kinked when they are wanted badly.

The time required to operate the facility seems to me to be very long. I am sure that with practice the individual fishermen will learn how to get the best possible use out of the equipment, but if it is going to take 10-15 minutes to handle each boat this means much too long a total time to deal with 20-30 boats, unless the device is to be regarded as a means of getting the local fleet out of the water at the end of the fishing season or at the beginning of the monsoon. As a way of getting boats out of the water when there is the least element of urgency involved, a time-scale of 10-15 minutes per boat could hardly be deemed safe or acceptable. The feature, however, which appeals to me very much is the simplicity of the operation. The crane or hoist, having picked up the boat, travels straight back to the landward end of the jetty, puts the boat down and immediately returns to the seaward end for the next boat; there is no time spent transferring the boat from trolley to transfer system, no waiting until a cradle is available. It is a simple pick-up-and-drop operation.

Mr. Bhakta has indicated that a wave height in excess of about 1 meter would make the operation of slinging a boat difficult or dangerous. Could he say what in his view is the safe limit of wave height for landing on the beach? If this is about half a meter, then the range within which the jetty would be used would seem to be rather narrow, making the provision of such a structure hardly justifiable.

Mr. Bhakta.

There will be somebody, appointed by the fishermen's cooperative, to look after the equipment and maintain it. Landing on the beach becomes difficult when wave height exceeds about 60-70 cm. A wave of 1 meter at the end of the jetty should be quite safe, but we must have a full-scale test; we will then find out what the difficulties are and how to overcome them. As to its range of usefulness, the jetty can be used at all times, up to a 1-meter wave, to land catches, which can be brought ashore by head-load or by the crane. A wave height of more than 1 meter is uncommon - probably not more than 50 days in a year.

Professor Bruun

We must be very careful in evaluating wave heights. We may say that we are satisfied if, in a certain situation, we can lift the boat out of the water 50 % of the time. If $\bar{H}$, the wave height 50 % of the time is 1 meter, then H, the significant wave, is 1.7 meters, and H max is approximately 2.5 meters. (These figures are slightly adjusted for the near-shore zone). Therefore the assessment of the jetty has to be based on $\bar{H}$ - and there are not many days at Ramayapatnam where $\bar{H}$ is more than 1 meter. The matter must be considered from a statistical point of view; in this way we can make a much better evaluation - and plenty of statistics are available for Ramayapatnam.

Chairman (Mr. Shiel)

May I seek a point of clarification? Is it correct to say that the structure designed by Mr. Bhakta acts as a landing place and a pier for most of the year, and then as a system for taking the boats out of the water on the onset of the stormy season?

Mr. Bhakta

That is exactly correct.

Mr. Godri (FAO)

With respect to the slings under the boats, I think it would be difficult and time-consuming to get these properly into position. Would it not be possible to put large hooks on the boats, as is done with lifeboats, to which lifting gear can be attached quickly? As regards landing fish on the walkway, this is three meters over high water level, and four meters over low water level - quite a distance for a small boat and would be most impracticable. It would also be difficult to prevent the boat, moored to one of the piles, from swinging under the walkway, and perhaps damaging the boat's superstructure. I agree that it would be desirable to have some fendering, to keep the boat in place and make landings of fish easier.

Professor Bruun

With regard to the placing of the slings, we are speaking of waves with an amplitude of approximately 1 meter; sometimes a little more. The horizontal surge may then be of the order of 2 meters, but no more. The boat is then coming in and it should be possible to bring its bow up against some elaborate fendering system such as is produced in Japan.

Mr. Gifford

I am sure that gear can be developed for handling a boat in waves up to about one meter, but I think there is more to it than that. It is not only the surge of the wave itself that has to be considered; when a boat is on a sea it tends to run downhill when the sea is coming with it and back again as the sea passes, so that it tends to plane back and forward apart from the actual motion of the water itself. These forces must therefore be checked - though I have no doubt that gear can be devised to do this. But I would like to strongly recommend that it be done as a prototype operation, before the whole scheme is put into effect. I am a little uneasy that we are considering a scheme here, and thinking of spending a good deal of money on it, which ensures that the boats do not fish during the monsoon period, when the waves at sea are such that they could fish - except of course in an extreme situation. Should not this Conference consider also - I do not mean as a substitute - ways of enabling the boats to continue fishing.

Chairman (Mr. Shiel)

What type of pile is proposed to be used in Mr. Bhakta's structure? I ask this because a recent PIANC article casts a good deal of doubt on reinforced concrete tube piles. I would be interested to hear of any experience or opinions on this point. We have used such piles in Ireland, and they seem to be standing up well, some of them after 30 or 40 years.

Mr. Bhakta

We intend to use bored piles, in which a steel case is driven and grabbed out; reinforcement is then placed, and it is filled with concrete.

Mr. Guckian (FAO), summing up the Session Discussions:

This project, developed by Mr. Bhakta's team in Bangalore, can be seen, therefore, to have many fine characteristics, and could be adapted for a number of uses in a variety of sites. There are, however, a number of important design construction and operational points which must still be further examined before it could be put into practice. It is on principle, well worth a trial, and it is hoped that its first application might be at Lawsons Bay near Vizakhapatnam in the State of Andhra Pradesh on the East Coast of India.

We, in FAO, would like to thank Mr. Bhakta for the extensive work that both he and his staff in his Bangalore office have put into the preparation of this scheme. We would like to wish it every success when a prototype is tried out.

(b) Mr. R. Moor (Peru-Netherlands) presented the paper submitted by Messrs Moor and Cabezas (see Annex IVf) illustrating many of the points in his introduction by slides and a

Two methods of beach landing are used in Peru for landing boats, or for bringing fish to the beach. North of Talara the system used is to bring the boats in on a slipway, the fish being brought in in baskets on small wooden platforms through the surf. At a few places in the north of the country, however, harbours could be built if funds were available, since there does not appear to be too much littoral drift.

In other places the fishermen are experienced in bringing vessels through the surf; they wait for the eigth wave and go in behind it. To get the boats into the water, six or seven people go on one side and perhaps half as many on the other side. Sometimes a tractor is used to push the boat into the water - it must go out before the next wave arrives or the tractor becomes stuck. Coming in, once the vessel is on the beach they put a wire around the upper part of the hull and haul it out with the tractor. We have hopes of improving this system, by fixing steel strips to the keels of the boats with pieces of wire attached, so as to speed up the attachment of the hauling wire. To push out the boats we have considered attaching some form of boom to the tractor, so that it can keep a little distance from the water.

In Peru they do not have sudden storm surges, such as occur in Holland. When a storm wave does come in it usually originates off the coast of Chile, with long-period high waves up to 20 seconds. A typical small-scale fishing community is at Parachique, where about 200 vessels catch some 20 000 tons of fish a year. This is a tidal inlet, about 9 km long. At the head of the inlet a causeway has been constructed, to carry a trunk road. This causeway has naturally obstructed the tidal prism. Five years ago aerial photographs were obtained of conditions from 1946, which suggested that the entrance to the inlet was unstable. When conditions had deteriorated to a stage when boats were unable to enter and leave at low water, money was made available for a survey. This included extensive bathymetric surveys outside and inside the inlet. Our first aim was to determine the tidal prism and to calculate the amount of littoral drift, so that we could see the size of the problem that we had to deal with. We had no equipment such as wave-riders, and therefore had to make use of the Sailing Directions for South America - very general but better than nothing. From these, and from diffraction diagrams, we calculated the annual drift as of the order of 100 to 150 000 cubic meters. We used a figure of 200 000 cubic meters, since our solution included the purchase of dredging plant and we wished to be on the safe side. A rough calculation showed that the tidal prism should be of the order of 4-5 million cubic meters, which gives a ratio that is not enough for a self-flushing entrance. We thought of improving the tidal prism by removing the causeway, and did a complete topographical and hydrographic survey of the inlet. We put in tide-recorders at several places in the estuary, and took simultaneous readings at these in order to arrive at the rate of tidal propagation through the estuary. All this information was sent to Holland where calculations showed that removing the causeway would not increase the tidal prism significantly; even doubling the existing prism would not produce a self-flushing entrance. We had therefore to find another solution. There were two basic problems; first, the entrance was not stable. The wind is always from the south or south-west and the entrance moves gradually northwards. After a time it breaks through the narrow bar, which may be eroded and damaged by heavy waves. After the break-through there is a small island left in the channel, with two mouths, and consequently a very shallow channel, too shallow for the fishing boats. Then the more northerly mouth fills up, the other becomes deeper and the whole process starts over again. We therefore thought about constructing two breakwaters. We did some float tests which indicated the direction of the incoming current and of the ebb current. We aimed to provide a depth of about 2 meters in the channel - the local boats had a draft of about 1 meter. This would give access at most levels and would allow larger vessels to use the harbour. This would require that one of the breakwaters would extend to a depth of 2½ meters. It would be desirable that the incoming tide should not form eddies. We would hope that the ebb current would carry some silt out to a bank that would be out of the channel, and for this reason we turned the down-drift breakwater at an angle. At the same time, it was hoped that by making the entrance a little narrower rather more depth would be provided and that

this might stabilize the entrance at one side.

This layout does not solve the problem of sand-transfer. If we simply build the breakwaters on these lines and leave them, then accretion and erosion would soon start and we would have the original situation over again, because we still do not have the necessary self-flushing ratio. And so we decided that a dredging plant was needed, to by-pass accumulated silt. Various types of plant were considered. The final design is still in hands in Holland. We want it to be as flexible as possible, so that it can be used wherever it is required, for dredging or reclamation inside the estuary, to provide sites for industry or houses, for dredging on the bar or to extend or deepen the channel, or for by-passing accumulated material across the channel. For this purpose we propose to build a short jetty, carrying a fixed pipeline with several discharge points, to which the dredger can attach itself.

The layout of the piers is such that they can be extended without a change of direction, if it is decided to deepen the channel in the future. Initially they extend to the 2½ meter line.

Professor Bruun

Mr. Moor's preparatory procedures are good. Constructing one jetty longer than the other is also sound. The problem here is - how much drift is cut off by building the jetties just so long. Experience in Florida is that if a jetty is extended to a depth of say 6 meters - depending on the wave action - this will cut off more than 50 % of the drift, so that the channel can be flushed. This does not solve Mr. Moor's problem, where the ratio is still too low. There may be various ways of handling the by-passing; I agree entirely that the arrangement should be as flexible as possible. A fixed plant here would probably be disappointing. Comparing the dimensions of Mr. Moor's problem with some known cases, there is a place in Florida called Hillsboro Inlet, where we constructed a flexible arrangement. There was very little wave action - a Mudcat could have operated. We built a submerged weir - the material passes over the weir. Hillsboro Inlet, Masonboro Inlet in N. Carolina, Eastpass and Ponce de Leon Inlets in Florida have all been designed in this way. I do not say that this is any better than what Mr. Moor has suggested.

Another way of approaching Mr. Moor's problem, which may not be possible in this case, is to collect the sand in a trap, as we did in the case of Sebastian Inlet in Florida. Conditions there were particularly calm, and we could place the trap just where there was a considerable widening of the cross-section and where a considerable deposit of material could be expected. In fact, almost all the sand was dropped in the trap. I do not suggest that this would work in Mr. Moor's case. I think flexibility is the key. I would probably have considered a submerged weir, but these do present problems. In storms they may be by-passed and undercut.

Mr. Gifford

I would like to comment on the situation at Santa Rosa in Peru. I think that three grades of fishery situation are beginning to emerge, in which the fishermen of Santa Rosa are in the top grade, doing very well in a difficult situation. In my view they require only a little help of a technical nature, and certainly not a lot of expenditure. On this question of expenditure, we have done a number of works in Britain under very strict economic control. I believe that to be reasonably viable a fishery industry can rarely afford capital works costing more than perhaps two or three times the value of the annual catch. We have tended to find expenditure of the order of £⅓ - £½ m in areas where the annual catch is worth perhaps £¼ m - these are very rough figures. I feel that there is a danger that we may find ourselves suggesting expenditure, for the developing world, of £2 - 3 m where the catch is perhaps £5 000 a year, and that we should be very careful on this point. But this is of course outside my field. To return to Santa Rosa, they have some very useful boats - very shallow draft but obviously well able to keep at sea. The fishermen are remarkably skilful at launching and landing them. Launching in fact presents

little difficulty - landing is the problem. There are two alternative methods, one of which, mentioned by Mr. Moor - the boom - has been used by the Portuguese for a long time. The boom used is a long one, oxen being used to push the boats out; the number of yokes of oxen depends on the strength of the offshore wind. It is important to keep the boat being pushed straight; the system is of course unstable. There would be four oars, with four men to an oar. A man sits in the boat looking aft, with the end of a rope in each hand. At the shoreward ends of these ropes are two very reliable men, with large poles with a spike on the end. When the oxen push the boat out into the surf, the bow will begin to swing away to one side or the other; the system being unstable it is bound to do so. The sea then catches the bow and if not checked the result would be disastrous - the boat would immediately be thrown up on the beach. The man on the opposite side puts his spiked pole into the beach and, as the oxen continue to push, the bow comes round to seaward again, and he pulls his pole out of the beach. The power exerted by the two men is quite small and does not slow down the oxen at all. As soon as the water is deep enough for the oars to operate, the man in the bow pulls out two pins and the ropes fall clear. This skilful operation has been going on for perhaps two or three hundred years. It is not a technique that could be easily transferred to another place. The oxen are, of course, also used to pull in seine nets.

In the early stages of the development of the catamaran, I did use a tractor. A 20-feet model catamaran was built. We fitted a frame to the front of an old Landrover, hinged and quite wide. This, when pushing the catamaran, did not have the same tendency to jack-knife, because the base was wide. I noted that the Santa Rosa boats are quite beamy. By using a tractor in reverse, because stability is better when the large wheels are to seaward, and mounting a wide-based frame on the back of the tractor, it should be possible to keep the boat straight as it is pushed out. If not, it would be simple to introduce the Portuguese system of guys to the bow - always remembering that a propeller raises problems with these ropes, which would have to be pulled in very rapidly by the men at the shore end. The pushing frame would, of course, have to be designed to drop free as the boat became waterborne. It seems to me, therefore, that the Santa Rosa fishermen simply need a helping hand on the details of their operations. Certainly, they do not need a port. The <u>second grade of fishermen</u> are in the situation where boats already existing cannot cope very well with the existing conditions, but where we cannot at present afford new boats. Here I think we have to provide some sort of protection - such as the open "skirt" wall already described- to enable boats that can almost cope to do so a little better. I am thinking of the very small boats. This is a field to which we should be giving some thought; I think that Mr. Pilon has some experience of this type of wall. I am worried that the solution for the Indian Ocean proposed earlier by Mr. Bhakta, which spends a good deal of money to enable the boats to get out during a good part of the fishing season. Perhaps we should be considering how best to create enough shelter to enable the boats to work off the beach at least during the less severe part of the monsoon (obviously, when the monsoon winds are at their highest nobody wants to go fishing). But there are periods, with waves of perhaps 1-2 meters, when the boats, <u>if they were at sea</u>, could fish. It is a serious matter for the fishermen to be deprived of their livelihood and income during the monsoon, which lasts for 2-3 months. A wave of 1-2 meters is not serious; the Peruvian fishermen cope with this all the time. It might be helpful to have the skirt breakwater in the Indian Ocean, offshore, not to produce calm water but only to reduce the seas to a manageable degree from, say, 2-3 meters down to 1-1/2 meters, which all sorts of surf boat can deal with. Such a breakwater will not deal with the big, 3-4 meter seas, but nobody wants to fish in such conditions. I think this relatively inexpensive system would be worth trying out, perhaps first of all in a model, to determine its effectiveness. The catamaran described in my papers was produced to meet the third grade of situation, where there is large surf running throughout the year. The vessel has to master 1-2 meter waves as a matter of course; it also has to be a trawler, with a range of 2-3 days. That was the brief, and we arrived at a fairly sophisticated small trawler. It has been suggested that we should be looking for a 1-day boat, not a trawler, capable of carrying about 5 tons, suitable for seine-net fishing and with a much simpler rig. We have in fact had such a boat in mind, and Mr. Gustafsson's remarks have set me thinking about it again. In effect, what is required is a boat consisting of two dories, perhaps with pointed sterns, about 9 meters long, with several bulkheads, connected by two beams, of laminated timber or steel sections. There would be a square or rectangular deck, quite strongly built with a frame on top on which is mounted

an engine, inclined to the stern, with a single propeller, a rudder and tiller. Each hull would have one hatch, with a high combing, and some sort of shelter over the helmsman. Such a boat could cost about $ 10 000, and could carry 5-6 tons of fish. It would do 4-6 knots and would stand up to any sea that I would care to face, and it would land in 2-4 feet surf (0.6-1.2 m). This is put forward as an idea which I think might be followed up.

To sum up, there are three distinct situations:

1. Where the fishermen are doing well in existing conditions and only need minor technical help.

2. Where civil engineering works are necessary to protect existing boats that cannot quite cope with the conditions.

3. Where new boats are required to meet a situation where there is no hope of a civil engineering solution.

Mr. Moor

I would like to thank Professor Bruun and Mr. Gifford for their helpful comments. We did consider a weir. One problem was that we had no facilities for a model investigation; also, we had difficulty in determining how high and how long the weir should be; we were also afraid that the ebb tide might tend towards one of the jetties, and might remove the sand-trap. Finally, we had not been long in this developing country, and we were very anxious that the design adopted should be as failure-proof as possible - we did not want to take any risks at all. As to making the southern jetty longer than the other, we did consider this, in the hope of trapping more sand. But this would have increased the cost of the scheme, and we had already had difficulties in obtaining the money for it; the total cost was about $ 2 m, without the dredging plant.

Mr. Delap

Could Mr. Gifford describe the form of breakwater that he proposes, to meet the conditions under his second heading?

Mr. Gifford

It would be on the lines discussed earlier - a series of piles, widely spaced, with a wave-breaker between them which would have vertical slats with openings between them of perhaps one third of the total area.

Mr. Pilon

I am not familiar with conditions on the coast of Africa or India, but I have noted the pictures shown here and have learnt something about the wave height to be expected and the fact that heavy weather is to be expected in certain months. You thus have a variety of problems; in certain situations the fishermen can fish, in others fishing is not possible. On the other hand, the range of wave heights is rather small - from 1 meter to 2 meters. So I agree that it should be possible to create sheltered areas with timber structures. We have done this in the Netherlands to provide small areas sheltered from waves of 1 to 2 meters height. A similar situation occurs in agriculture, where shelter belts of hedges, trees or houses provide shelter against the wind for fruit-growing.

A good deal has been said about the movement of sand along the coast. It is necessary to know how much material is moving in a direction perpendicular to the coast, and if the quantity is so much that it will cause difficulties? I would think that if a sheltered area is provided by piles and some timber constructions with spaces between, sand transport should be able to go on without accretion. If this works it makes it possible to provide sheltered areas for small-scale fisheries in developing areas.

Professor Bruun

There has been reference to the situation in India, where the major part of the drift occurs at or immediately inside the breaker-zone. There is a pier in S.E. United States of about 250 meters long, where we have made extensive studies and we know how the drift is distributed. The important point is that as soon as a brake is put on the drift, the shoreline configuration is changed, material accumulates on one side, it creeps around the end. Mr. Pilon referred to a penetrable structure, or one which sand can by-pass, where the configuration may not be changed very much. We have experience of permeable structures in various parts of Florida. If the piles are placed too close together scour is a problem, and the stability of the structure may be endangered. This has happened so often that it is hardly possible to use such a design. However, for damping wave action in front of a coastline different types of breakwater are possible. The best would be a simple rubble mound. In order to obtain the benefit of such a structure it must be put outside the breaker zone, and so becomes rather costly. Skirt walls and piles have been mentioned. This field has been investigated very extensively, and a lot of information is available. In locations such as the Zuider Zee it will certainly work. We have an actual installation under test in the northern part of Norway, with waves of 4-6 seconds. On an open shore they will not work, for reasons of wave mechanics - the wave-length is too long. For reasons of soil mechanics it is impossible to support the structure, remembering that one cubic meter of water weighs one ton. If the load is reduced by curtailing the horizontal part to "mini-skirt" proportions it is not very effective. The wall of single piles may work, though the piles may be rather expensive. The piles must be quite close together; to give 50 % wave reduction permeability must only be about 30 %. Something can therefore be done, but it will not be inexpensive. The problem is to destroy wave energy. Thic can be done by friction, turbulence, heat, and the structure must absorb this energy. The better way is to put the energy back into the ocean, though this in turn will cause problems with navigation, due to reflected waves, and problems with scour. As soon as any structure is put out into the ocean new problems have to be solved. The Dutch have met the problem with "piggy-back" groynes, that means piles sitting on top of a basalt pitching groyne. The piles break the waves. But I do not think that many of these designs have been used recently. In Kent and Sussex, and elsewhere in England, scattered pile walls, parallel to the shore, do work, because the beach material is so coarse; they do not work anywhere else. But this type of structure should not be ruled out. It must, however, be put outside the breaker zone.

I think we have to come back to the statistical approach. If Mr. Gifford's boat can operate in certain conditions, and if in order to make its operation feasible a wall of such a size is necessary, then we must see how much it will cost to provide the conditions and, taking all factors into account, see if an adequate cost-benefit ratio is achieved. Such a combination of naval architecture and wave mechanics is a very useful approach.

Mr. Bhakta

In Ramayapatnam observations and calculations showed that littoral drift extends beyond the 6-meter contour. Between 3 and 6 meters it is quite strong. If any structure has to extend beyond 6 meters it can become very expensive. Mr. Moor is certainly very fortunate that he can get \$ 2 million for such a small fishery unit protection. In most countries, I am certain \$1 000 000 might be available for such works in the fishery sector.

Mr. Guckian

In Madras, in 1913, a short seaward extension was built to the existing breakwater out to about the 6-meter depth, and it was thought that the drift problem had thus been solved since the sand stopped obviously accumulating. Some years later it was realized that sand was still moving, even out beyond the 6-meter contour, and was accumulating at other points in the harbour area, causing further extensive hindrance to harbour operation.

In answer to a question from Mr. Delap, Mr. Moor then gave a detailed description of the Travellift as used at Parachique, to get vessels of up to 7 tons in and out through the surf. One problem in operation was noted, that is that some of the boats have masts that are not dismountable; these cannot use the travellift.

It was intended that once a vessel was on the cradle it would be brought to a storage site, being supported there while the cradle was pulled out, to be used for the next boat. In practice the fishermen will not take the trouble to do this, so that it is necessary to have 8–10 cradles, and only 8–10 boats can be handled at a time.

Mr. Wong Kim Yok

Mr. Moor has described facilities for lifting boats at Parachique. It seems that this is in a very calm inlet. Is it necessary to take the boats out of the water in such calm conditions?

Mr. Moor

The lifting arrangement is for maintenance, of hulls etc., not for unloading fish. There is a quay about 200 meters long for that.

The Chairman (Mr. Shiel), winding up the session, felt that it was an opportune time to briefly sum up this Session and some of the previous week's proceedings. These Sessions covered the difficulties involved in across-beach operations – which are so many that it seemed at times as if there was no solution, though there were indications that some solutions might be gradually emerging. A very interesting paper on the design of craft; a discussion on methods of taking craft from the water, and of landing catches; a wide-ranging review of methods of dealing with littoral drift; an examination of the formula relating the tidal compartment with the volume of littoral drift and the possibility of keeping an entrance open by discharge of the tidal component; a discussion on methods of reducing wave height. It was now necessary to consider what the next steps should be. It would be hoped that some firm recommendations might come from the Consultation for follow-up projects to be initiated by FAO, some of an experimental nature, which could give lasting benefit to the smaller-scale fishermen, especially in the developing nations.

7. SESSION VI

Case Study Solutions

The Chairman (Mr. Shiel)

It is proposed to devote this session to Case Studies under the following headings:

(i) Basic Principles to be taken into account for Coastal Structures

(ii) Basic Principles in dealing with specific projects.

(iii) A General Philosophy to recommend to FAO, concerning the provision of assistance to Fishery Projects for their Member Nations.

Professor Bruun is requested to introduce the discussion under the first two headings and then the Session will be open to discussion. Thereafter it was proposed that the third point should be dealt with in Session VII.

Professor Bruun

(i) Basic Principles to be taken into account for Coastal Structures. I shall deal first with the principles used in the design and placing of coastal structures. The most primitive coastal structure is just a small jetty built perpendicular to the shore, which produces a steeper profile, on the updrift side, and so provides a better landing for whatever boats there are. This structure does not provide any protection against wave action; here the parallel structure comes in - the angular or T-groyne or the detached breakwater. Judgement has to be used in placing this; it must be placed outside the breaker zone. If there are two or more breaker zones this presents a problem, but waves will not always break on the outer bar, or bars; usually breaking occurs only on the first bar, nearest the shore. It will depend on the steepness of the profile, and on the wave characteristics. With respect to design, in relation to layout and to exposure, I shall classify shores in terms of exposure: first, exposed shores with quite a lot of wave action - such as occur in India during the Monsoons and for some months in Nigeria and in Ecuador. In these cases, some form of rubble mound is almost always necessary, but it has become possible to make these structures less expensive by using new design principles - different profiles and different ways of placing varying rock sizes in relation to the profile. Little thought has been given to this subject in the past, but a PIANC committee is now working on the problem and will produce its recommendations within the next year. Again, jointed structures may be used, such as have been built in Holland for many years, with various kinds of joint filling, but most commonly asphalt. These have been used on very exposed shores - I have previously mentioned one Danish case. Next we have medium-exposed shores, as on a large part of the Indian coast and also in Nigeria and Ecuador, for much of the year. Rubble-mound and joint-filled structures can be used but here piled structures have a definite use. New types of piled structure are already being used, offering certain possibilities which we did not have in the past, such as the possibility of adjusting the structure to wave action. Most piled structures are positively tied together with the space between filled up, but this is not essential; it is always expensive to place things very accurately and it may be permissible to leave a certain amount of space between piles.

Finally, we have less-exposed, or little exposed shores. Here again piled structures can be used, as well as such specific structures as skirt walls and floating breakwaters of various types. These may be useful, but every specific case should be studied on its own merits, and designed accordingly. Needless to say, one must be sure that the structure, whatever it is, does not work just for a relatively narrow range of wave-periods; we must know the wave characteristics extremely well before using that sort of solution - or at least we must be sure of being able to make adjustments. There is a considerable amount of data available on the functioning of these designs, most of it quite new and only available during the last few years and still not complete.

I spoke of design. It is very important that we should consider the vessels that will be used. The works must be designed from the operational point of view - what wave action will allow the structure to be used by these boats, and how often will that degree of wave action occur? Mr. Gifford has pointed out that it is not necessary to reduce wave action to zero, but only to the level that is acceptable to the vessels concerned. This is very important. Soil mechanics are also extremely important - the foundation conditions, particularly for piled structures of all kinds and for rubble mounds, and in relation to erosion. Whatever structure is put up it must not suffer from scour and so be in danger of collapse. Therefore I think that there is a need for guidelines for drawing up Terms of Reference for the preparation of such projects.

With regard to the layout of open structures, here again it is extremely important to know a lot about the wave action. In this respect the case of Ramayapatnam in India might be examined. The investigation produced data important for evaluating where the structure should be placed, and also for studying the operational aspects of the structure in relation to the vessel used. Up to this time the vessels themselves have not been considered. With regard to interference with littoral drift, it is not very important to settle whether the distance between bents of piles should be 5 meters or 10 meters - this makes very little difference to the littoral drift - but a pier has to be properly located in relation to wave action, and to the fluctuations of bottom and beach profile. I would repeat; it is absolutely essential to have reliable physical data, for design as well as for operation. This is often ignored, being replaced by inadequate "rule-of-thumb" working.

As to the design of open structures, piles should be of concrete, pre-stressed if possible, or fully creosoted timber (at 22 lbs per sq. inch). A great deal of testing of steel structures has been done around the world, which demonstrates that it is not practicable; whatever preservation coating is put on it will quickly wear off. Steel groynes were put in at Palm Beach in Florida, the steel being 12-13 mm (1/2 inch) thick. They were completely destroyed in three years, worn through by the sand and water. The type of pile used will depend on practical circumstances, as Mr. Guckian has previously stated. Round piles are best where resistance offered to waves is important, otherwise square piles, sometimes with a built-in jetting pipe, are preferable. The deck can be removable, but this requires stronger bracings, capping beams and walings. One has to be very careful about this; since in the North Sea, on the Dogger Bank, spouts of up to 30-40 meter high have been seen. Several years ago a British destroyer was turned over by such a spout in a well-documented case in Admiralty records.

Fender systems should probably be of the expendable tyre type, cheap and easy to replace. If cranes are installed the boom type requires a stronger support than the gantry type. As already mentioned, no project should be undertaken without detailed knowledge in advance of the forces between boats and the structure, of the behaviour of the boat in relation to the structure and of other operational features. As to the structure a model can be made fairly easily; all the information is available. At the same time, such a model can give little information about operation; in general, operation tests must be full-scale. There may be facilities available (e.g. existing piled structures) where such operational tests can be readily carried out.

A few words about tidal entrances and estuaries; in such entrances where a commercial port is already established, there will usually be no technical difficulty in placing a fishing port, provided space is available then and in the future. However, many ports do not like to have fishermen in the harbour, and this frequently creates serious development navigational and operational problems. Tidal entrances on shores subject to heavy littoral drift usually cannot be improved, because the cost is too great for the economy of a small-scale fishery. However, if the drift is modest, some less-exposed entrances may be improved by relatively economical means, either by means of a self-flushing channel or by some other composite system. Improved maintenance technology, for example, in the form of small efficient dredgers which may be shared by several small inlets, or by the use of the new bottom pumps developed by the US Army Corps of Engineers, offer new possibilities, if properly applied. These however all require full data and meticulous planning. There are

new devices being developed designed for the express purpose of cleaning tidal ent: where the tidal prism is too small to flush the channel. A report prepared by the Army at the Waterways Experimental Station at Vicksborg, Mississippi, on tests made on tidal entrances in Florida will be published soon. Flushing of entrances by air-curtains may become important in the relatively near future. Otherwise, training walls may be used to improve estuaries, as has been done in numerous cases. This is not very easy. Mr. Pilon has referred to the use of Dutch fascines to form training walls and these are cheap, but they require continuous maintenance.

(ii) As to basic principles for specific projects, I think that we can simply mention certain principles which can be tested. I shall refer to a few cases which I think have some merit. Those who have detailed information about projects in different parts of the world will, however, be best able to do this.

Let us assume that there is a site where some protection is needed to make a better landing, where conditions are not too exposed but where we still have to consider a rubble mound. The T-type groyne would be quite suitable, or possibly a joint-filled structure - to reduce rock size where heavy equipment is not available. Again, the structure must be considered from the operational as well as from the structural point of view. It is necessary, by studying the wave-action and the coastal geomorphology of the place, to determine how long it should be in order to extend outside the breaker zone. We arrive at a result which reduces wave-action to a level that will allow a certain number of boats to be used for perhaps the entire year. Piled structures of the type described earlier can produce the same result, where the structure can be adjusted to the wave-action that it will withstand. The tight wall has some disadvantages, being fully exposed and therefore subjected to higher forces than a wall of piles with some space between them. A suitable piled wall breakwater might be formed of piles about 80 cm in diameter consisting of pre-stressed elements, spaced about 20-30 centimeters apart with a heavy capping, probably cast in position. It may be feasible to build a trestle out to the wall, but it would be fairly easy to erect because the elements are not heavy. There are places, of medium exposure, where such piled structures could be tried out. Floating breakwaters, pontoon or buoy type, skirt-walls and the like might be tried out in little-exposed to medium-exposed areas. Again it would be essential to evaluate properly the type of wave action that would be produced, and the sort of service that the structures would give; otherwise one cannot judge the value of the structures. Then it becomes a matter of adjusting the design to the actual case under consideration. Open-trestle piers certainly have merit in places where wave-action is not too severe; the supporting piles have to be stable and this means a certain minimum dimension, so that they will not be turned over by direct forces or because of scour. A number of designs are available for hollow piles and for other types. It is a good idea to put cranes on these piers. A crane should be as simple as possible, and to operate by the fishermen themselves.

With regard to tidal inlets, there are many cases where existing entrances are already being used, but now new designs are becoming available, with which it becomes possible to help entrances which are not fully self-flushing. I would again mention the new submerged pumps which have been tested in Florida. Considerable information about these is available from the US Army Corps of Engineers. There are also new transfer pumps easily handling 100 000 cubic meters per year, which can operate from a shrimp boat and can be easily taken from one place to another. It is necessary to have a power unit, or a power supply ashore, into which a cable from the pump is plugged.

Finally, I am sure that Terms of Reference for consultants for projects must be carefully prepared. Many worries have been expressed about data which is not available. This data should be , and secured by people who understand what it means.

There is a problem that we meet in many places. A project has been properly desi and built. Now comes the operation and maintenance of it. In most developing countries they are not experienced in maintenance. Also, it is not reasonable just to complicated installation unconditionally and expect that it will be properly looked after. Unfortunately, some politicians and administrators do not always understand this.

The financing agency should make it clear that full advantage from a new facility will only be obtained if it is operated and maintained in a certain manner. Responsibility for operational management and maintenance must be firmly placed on someone, as one condition of assistance.

Mr. Gifford

There is, I feel, an alternative approach to the one outlined by Professor Bruun, an approach which, although I am a Civil Engineer, should perhaps diminish the civil engineering element a little. A number of situations have been described where the funds available are small, both for civil engineering works and also for the provision of new boats. I believe that these are the very critical situations, in which people are looking to us for assistance and advice. It may be that the advice that we shall have to give is that very little can be done. The situation where it is possible to build a groyne, such as has been described by Professor Bruun, or where it is possible to finance a new fleet of boats, along the lines that I have discussed, are probably not now problem areas. I feel that the problem areas are those in which the exposure, or the littoral drift, is so great that it would be unwise to build engineering structures, or in which fleets of boats already exist and where it would therefore be economically unsound to scrap the existing boats and build fleets of new boats. There are cases in which certain things can be done. A good example is the situation in northern Peru, where quite primitive people, of their own ingenuity, perhaps led by someone at one time, have developed boats, based on a very ancient European model, with techniques enabling them to do those things that they need to do. Life has been made a good deal easier for them by the occasional use of an agricultural tractor; it could be made still easier by the addition of about $ 1 000 worth of equipment added to that tractor, to make it even more successful. Another type of case exists, perhaps in areas such as those indicated by Mr. Wong, where substantial fleets of boats have been built up in certain estuaries - efficient boats (long-lived because of the timbers used to build them) not readily thrown away. During certain seasons of the year they are in great danger, but because of economic necessity people are more and more anxious to fish during this dangerous season. These seem to me to be the difficult areas now. All we can say is that, if the littoral drift is not too great, there are certain types of structure, which have been described by Professor Bruun, that can give some protection. If the litteral drift is very severe, we may have to advise the fishermen to move their boats to another area where they will be safe, while substituting other types of boat in the difficult area. I would like to feel that we would give some attention to these situations in addition to considering the structures that Professor Bruun has described. By attention, I do not mean that this meeting must necessarily arrive at solutions, but that in our proposals we ought to that there are fields of sensitivity which call for investigation.

Mr. Gackian

On behalf of FAO, I would like to thank the last two speakers, Professor Bruun and Mr. Gifford, for their very interesting contributions this morning, which, together with all their many previous contributions, have given us much very helpful information to guide us in our future activities.

Mrs. Joyce Gifford

Can anyone say if there is anywhere in the world a successful, economic method of providing shelter for boats using an open beach exposed to rough seas. I had hoped to hear of some successful solution, of even one structure that has stood for 10, 20 or 30 years, and to learn how this has been achieved and how erosion has been dealt with. But only one or two half-solutions have been mentioned, none on a really exposed shore.

Professor Bruun

The problem of littoral drift is serious; that is why the open jetty comes into the picture - we simply allow drift to pass through. A projecting structure will naturally interrupt drift; it may be possible to place it where erosion does not matter, but usually it does.

In Florida, more than 20 years ago, the situation was bad; groynes of many kinds were built which did much more harm than good. They then introduced the typical British groyne, from Kent, Sussex and South Yorkshire, an adjustable groyne working on the to-be-or-not-to-be principle. This can be built and then you may decide that it is not wanted and take it away. If the problem is serious it can be met by taking away the structure for part of the year. Examples of structures on an open coast can be seen at several places along the north west coast of Denmark, and at Casablanca, but none are, however, for small-scale fisheries.

We must distinguish between very exposed, medium-exposure and low-exposure coasts. These small piers or groynes which were built on the Danish coast 40-60 years ago certainly have benefitted the area and they did not cost too much. Erosion was not of particular concern in those days. These groynes produced a steep beach on one side, which is important for the launching of boats. Hand-powered winches were installed. We can certainly build structures of the same kind today, even on exposed coasts, and we will get something which has some merit, and which has been proved to be useful. But perhaps it is time to modify these structures; they were built of heavy concrete and would cost much more today. They can be built in an easier way today at relatively lower cost. I agree that we should try structures of that kind.

I have had experience, when planning landing operations for NATO, of driving amphibious trucks through surf in the Pacific, where the waves were 5-6 meters high, of 13-13 second period. This was not easy but they were powerful craft. The US Navy has developed, and mass-produced at not very great cost, amphibians which have a well in which they can carry up to 50 smaller boats. They bring these boats out through the surf and launch them outside the breaker-zone, bringing them back afterwards to the shore. This system has already been designed and exists. The US Navy has also designed a floating breakwater that can pass through a lot of surf and can be useful in landing operations. Unfortunately, FAO needs to be concerned with cost; the Navy does not. But one could pick up certain ideas from them. I am myself working on the design of such a floating arrangement which can be launched in almost any kind of weather with a good chance of getting through. The Navy has craft of very special design, some with small jet engines. We could not use these but they have features which might be usable in an inexpensive design.

__Mr. Gifford__

I am worried about the relationship of cost to industry. No doubt these problems are soluble, at a cost, and have been solved in terms of coast protection works and large-scale harbours, even medium-scale harbours. But we are thinking about an industry with a turnover of only perhaps a few hundred thousand dollars a year in many cases. But I think there are many countries, and I believe that Mr. Wong represents one of them, where they cannot afford costly works. My wife's question is relevant; is there anywhere that a low-cost fishery has benefitted from an engineering structure that works and is in use? If not, I think that we must say so. And we must say how it could be done and ask for funds and go ahead with the necessary research. We must not appear to be too confident or we may not get the funds for the research that must be done.

__Mr. Guckian__

To return to Mrs. Gifford's question, there are several reasons why we cannot point out results at present. A few structures that were attempted now no longer exist, their lifetime being remarkably short. There are a number of reasons for this, apart from engineering design. Most Fishery Departments have a Director of Fisheries who is generally a non-technical administrator or a biologist. He may never have been out in a fishing boat, nor even desire to do so. He knows little of the industry. To make matters worse, he has no specialist engineers to advise him, but has to depent on staff from the Bureau of Public Works, with experience in road building at most to give such advice, since in most countries these Bureaux have no connection with marine works. Engineering advice coming from such source regarding marine structures is usually to say the least inadequate and many of the resulting structures have disappeared. Mr.Moor estimated that the breakwaters at Parachique

might cost $ 2 million, apart from the other works and continuous dredging. He is fortunate to have a government that will consider work of this cost for a small-scale fishery development. Most countries are thinking in terms of $ 0.5 million dollars for a complete fishery unit. The trouble is often an economic rather than a technical one, and is not confined to the developing countries.

Mr. McGrath

In the course of his most interesting address Professor Bruun offered to make available to those seeking it information on, I think, wave action on, or passing through, piled structures and skirt-walls. I am not sure if we are assuming that Professor Bruun will automatically do this, as he always seems ready to do, or if we should make a formal request for this information. If this offer has not been formally taken up, may I suggest that we should do so now.

Professor Bruun

To start with skirt-walls, you might write to the Director of Maritime Works in Norway for all available information on skirt-walls. There is a very comprehensive report - I am not sure if it is in Norwegian or English. With regard to the design of scattered piles, I am afraid that I must refer you to my own book, which contains a lot of data on information sources (Reference No.3). The PIANC Committees on Wave-Action and on the Reception of Large Vessels (the mathematics for large and small vessels are the same) will shortly have publications ready. I am a member of both committees and I will try to arrange an exchange of information with FAO.

Mr. McGrath

I apologise for pressing this point. I understood from Professor Bruun's remarks that there is a lot of information available, waiting to be assembled and collated, which would be of particular value in the study in which we are engaged. My query is really addressed to FAO. Would it be possible to offer an assignment to Professor Bruun to undertake this exercise - to put all this dispersed data together in one volume, with the needs of the small-scale fishery operation particularly in mind?

Mr. Guckian

We would very much like to have a register containing all this information. No one volume or index contains it all as far as I know. Unfortunately, little money is provided in our budget for this sort of work. We do have a small floating sum which we would hope might be used for a follow-up to this Consultation - not only for a book but also on some work on development. I shall keep this in mind for future action.

Chairman (Mr. Shiel), winding up the Session presentation and subsequent discussions, stated:

Professor Bruun has outlined certain principles for consideration when dealing with coastal structures for small-scale fisheries. Mr. Gifford has proposed a slightly different approach. There is, perhaps, a need for an interdisciplinary approach to the various problems with which we are concerned. Our view as to the precise nature of the problem will vary; is it a problem of establishing a fishery? Of providing shelter? Of providing landing facilities? Of giving an extra push to a boat to help it to get off the beach? Or is it primarily a problem of training or educating the people involved? There are many other possible lines of approach. If, however, the experts in time come up with something better, this may undermine the confidence of the fishermen in the original solution; they may feel that the experts cannot know their job if they gave the wrong solution in the first place. This is obviously an important consideration in a developing community.

Following the end of this Session a number of films were presented by:

(i) Mr. Breimer on the FAO/UNDP Project for the Development of Fishery Harbours in India, prepared by Scandiaconsult, the Consulting Engineer Firm who provided much of the technical services for this project.

(ii) Mr. Van Steenwijk on the provision of an anchor which might be suitable for vessel haul-off arrangements on open beaches, and on the operation of beaching and launching of coastal-based lifeboats in the Netherlands.

8. SESSION VII

The Chairman opened this concluding Session by remarking that it would cover it 10, 11 and 12 of the Agenda.

Item 10, Any other questions, led to lengthy and detailed discussion on what dations should be framed to guide FAO in their future programme of works in the small-scale fishery sector with particular emphasis on the civil engineering sectors. This was in essence the third point of the Session VI discussion which was postponed to be dealt with in Session VII.

These recommendations, agreed unanimously by all participants, were as follows:

Projects should be undertaken, if possible, in cooperation with other appropriate agencies, in the following fields:

1. Inexpensive shore stabilising structures providing some protection against wave action, including improved designs of rubble mound or piled structures, for exposed sites.

2. Improved energy-absorbing and wave protection structures, floating and fixed, for moderately exposed shores.

3. Trestle piers, with or without removable decking, with mechanical boat lifting devices - with special emphasis on operational aspects and on the frequency with which these facilities can be used.

4. Continuation of the development of improved fishing craft, of a range of sizes, for use on open beaches.

5. (a) Self-maintaining tidal entrances and estuary channels.
   (b) The organisation of dredging operations to serve several sites.
   (c) Inexpensive dredging equipment to deal with modest siltation.

6. Devices for the launching and recovery of existing or improved craft in across-beach operations.

To the extent that it is possible, FAO should function as a central agency for the dissemination of information on the planning, design and operation of facilities for small-scale fisheries, and to provide as soon as possible a register of all available documentation on aspects of coastal engineering problems relating to the small-scale fishery development.

Item 11. Adoption of the Report. A draft of the Consultation Report was read and dis-sed and was subsequently distributed to participants and other interested parties in its final form as in Annex III.

Item 12. Closing of the Consultation. The Chairman (Mr. Shiel) thanked all participants for their very interesting contributions throughout all Sessions of the Consultation. He wished also to thank all those staff members of FAO who helped to make the Consultation such a successful event. He wished all visiting participants bon voyage on their return journeys home, and a period of very fruitful work in the solution of their problems concerning their national small-scale fishery developments.

The Government Consultation was then formally closed.

ANNEX I

GOVERNMENT CONSULTATION - ACROSS BEACH OPERATIONS IN THE SMALL-SCALE FISHERY

Statement by A.A.W. Landymore, U.K. Permanent Representative to FAO in Rome in connection with Agenda Item 5, Design of Special Vessels

The British Ministry of Overseas Development has, over the last two years, been financing trials with the catamaran fishing boat, which Mr. E.H. Gifford has been carrying out. As he has explained to you, the trials have been extremely successful. We are now anxious to make sure that the surf landing techniques so evolved are widely available to developing countries which have the need to carry out fishing operations across surf beaches with larger craft than have been used until now. I understand that the Nigerian Government is considering ordering two of the catamaran fishing boats for operations at Lagos.

We are particularly concerned to further the welfare of peasant fishing communities in developing countries, and the provision of this type of craft seems to be well-suited to achieve this aim. Mr. Gifford has explained to you the size and capabilities of his catamaran fishing vessel, and we hope that countries with fishing communities who could benefit from the introduction of this type of craft will give serious consideration to it. Her Majesty's Government, for its part, is prepared in principle to consider financial or other assistance in this field to the Governments of developing countries in which there are UK aid programmes. Enquiries will be welcomed, though I should add that formal requests are required from Governments of countries concerned before any substantive action can be taken, and that in considering such requests the ODM must, of course, have regard to the usual aid criteria concerned with the economic justification for the project and its placing in relation to the country's overall aid priorities.

Finally, I should like to express my Government's gratefulness for the enthusiasm and efficiency which Mr. Gifford has shown in developing an important new approach to assisting peasant fishing communities, and I trust that his proposals will receive widespread endorsement.

ANNEX II

GOVERNMENT CONSULTATION - ACROSS BEACH OPERATIONS IN THE SMALL-SCALE FISHERY

AGENDA

1. Opening of the Consultation.
2. Adoption of the Agenda.
3. Election of Chairman.
4. Consideration of coastal engineering problems affecting the development of small-scale fishery operations.
5. Design of special vessels, gear and equipment for use under difficult coast conditions.
6. Static structures - e.g. open jetties, breakwaters - for use in the development of small-scale fisheries
7. Mobile and other mechanical structures for use in across beach operations.
8. Consideration of specific projects submitted.
9. Case study solutions.
10. Any other questions.
11. Adoption of Report.
12. Closing of the Consultation.

ANNEX III

GOVERNMENT CONSULTATION - ACROSS BEACH OPERATIONS IN THE SMALL-SCALE FISHERY

List of Participants and Terminal Report

1. PARTICIPANTS

(i) Chairman

S.J. Shiel (Irish)
Chief Engineer, Office of Public Works
51 St. Stephen's Green, Dublin 2, Ireland

Secretary

W.J. Guckian
Senior Fishery Industry Officer
(Civil Engineer)
Fishery Industries Division
Department of Fisheries, FAO

Assistant Secretary

M. Breimer
Fishery Industry Officer (Civil Engineer)
Fishery Industries Division
Department of Fisheries, FAO

Rapporteur

H.A. Delap (Irish)
Consulting Civil Engineer
Ards, Cabinteely, Co. Dublin, Ireland

Assistant Rapporteur

A.H. Godri
Fishery Industry Officer (Civil Engineer)
Fishery Industries Division
Department of Fisheries, FAO

(ii) Specialists

Per Bruun (United States citizen, Danish-born)
Professor in Coastal and Port Engineering
Technical University of Norway
7034 Trondheim, Norway

H.A. Delap, BE, FICE, F.IEI. (Irish)
Consulting Civil Engineer
Retired Chief Engineer, Office of Public Works
Ireland (address above)

E.W.H. Gifford, B.Sc., FICE, FIStructE.,
(English)
Senior Partner, E.W.H. Gifford and Partners
Consulting Engineers
Southampton, England

J. Pilon, M.Sc., Eng. (Dutch)
Chief, Hydraulic Section
Hoofd Waterloopkundige Afdeling
R.W.S. Bureau Hellevoetsluis
Kawaalweg 20.Z
Hellevoetsluis, Netherlands

(iii) Observers

(a) Representing Member Governments

India	N.P. Bhakta Director, Pre-investment Survey of Fishing Harbours 64 Palace Road Bangalore 56000052
Ireland	S.J. Shiel Chief Engineer, Office of Public Works 51 St. Stephen's Green, Dublin 2, Ireland
	C.J. McGrath Inspector of Fisheries and Fisheries Engineer Department of Agriculture and Fisheries Agriculture House, Kildare Street, Dublin 2 Ireland
Malaysia	Wong Kim Yok Head of Technology Section Fisheries Division, Malaysia Ministry of Agriculture and Rural Development Swettenham Road, Kuala Lumpur
Netherlands	Ronald Moor Project Manager Fishery Harbour Development Project c/o Dutch Embassy, Casilla 71, Lima, Peru
Peru	Moises Cabezas Chief of Engineering Office Ministry of Fisheries Lord Cochrane 351 of. 405, M raflores, Lima
U.K.	A.A.W. Landymore U.K. Permanent Representative to FAO British Embassy, Rome

(b) Representing Agencies

OECD	Paul Adam Chief, Fisheries Division Agriculture and Food Directorate, OECD 2 André Pascal 75775 Paris 16, France
PIANC	Eugenio Baratono and Carlo Ranieri, Civil Engineers PIANC, Residence Palace Quartier Jordaens Rez-de-Chaussee, Rue de la Loi 155 1040 Brussels, Belgium

(c) <u>Representing other Organizations</u>

The Institution of Civil Engineers (London)	E.W.H. Gifford
The Institution of Civil Engineers of Ireland	H.A. Delap

(d) <u>Others attending the Consultation</u>

Mrs. Joyce Gifford
Bartley, Southampton, England

F. van Steenwijk
Private Consultant
Alfred Nobellaan 517
De Bilt, Netherlands

(iv) <u>FAO Staff Members attending</u>

H. Watzinger
Director, Fishery Industries Division (FII)
Department of Fisheries

W.P. Appleyard
Chief, Fishery Industries Development Service (FIII)
Fishery Industries Division

P. Gurtner
Chief, Fish Production and Marketing Service (FIIM)
Fishery Industries Division

A.M. Anderson
Fishery Industries Officer
Fishery Industries Division

C. Nédélec
Fishery Industry Officer
Fish Production and Marketing Service

J. Fyson
Fishery Industry Officer
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O. Larsson
Associate Expert
Fishery Industries Development Service.

F. Bourgois
Fisheries Officer
FAO/World Bank Cooperative Programme (DDCB)
Development Department

N. Gustafsson
Senior Fishery Officer (Industry)
Indian Ocean Programme
Operations Service

M. Zei
Consultant,
International Project for Development of
Fisheries in the Eastern Central Atlantic (CECAF)
Operations Service

Miss C. Witherspoon
Clerk-Stenographer
Fishery Industries Development Service

2. The Consultation opened on 1 July 1975, when Mr. H. Watzinger, Director, Fishery Industries Division, Department of Fisheries, delivered an address welcoming the participants to the Consultation. Following adoption of the Agenda, and the unanimous election of Mr. S.J. Shiel (Ireland) as Chairman for the Consultation, Mr. W.P. Appleyard, Chief, Fishery Industries Development Service, Fishery Industries Division, introduced the subject matter of the Consultation, pointing out that this was particularly appropriate in view of the interest being shown at present by many countries in small-scale fisheries. He gave a resumé of FAO policy - which is, briefly, to encourage governments to think about their small-scale fisheries and to tackle the problems which exist on the beach and in the fishing community.

3. The Consultation approached these problems under four main headings - each introduced by one of the participating specialists - the first four Sessions being arranged accordingly:

Session 1: Introduced by Professor P. Bruun

Consideration of coastal engineering problems affecting the development of small-scale fishery operations.

Session 2: Introduced by Mr. E.W.H. Gifford

Design of special vessels, gear and equipment for use in difficult coast conditions.

Session 3: Introduced by Mr. J. Pilon

Static structures, e.g. open jetties, breakwaters for use in development of small-scale fisheries.

Session 4: Introduced by Mr. H.A. Delap

Mobile and other mechanical structures for use in across-beach operations.

In each Session the introductory statement was followed by questions and supplementary statements, and comments by the specialist concerned.

4. Dealing with coastal engineering problems, Professor Bruun distinguished between shores with littoral drift (either open beaches or beaches associated with tidal inlets and estuaries) and shores without drift. He pointed out that most shores were subject to drift and described ways in which conditions on them could sometimes be improved by relatively inexpensive means, for example by rubble mounds of special form and profile, by new construction techniques and by new types of shore-protecting and energy-absorbing structure

capable of adjustment to changing conditions. He indicated the limits within which a tidal basin or inlet is self-scouring, and referred to recent developments which simplify the transport and handling of sand-pumping plant, and to other ways of reducing the cost of dredging. He emphasized the importance of adequate and accurate data on which to base all marine designs; wave height, storm frequency, tidal currents, volume of drift material and other factors.

5. A number of participants described ways in which across-beach problems were being dealt with in their countries, by the use of special craft, or special equipment or techniques for launching and recovering boats. A point repeatedly stressed was the importance of low first cost and maintenance costs in small-scale fisheries.

6. Mr. Gifford, introducing the subject of special vessels, gear and equipment for use in difficult coastal conditions, described briefly promising trials, under operating conditions in England and West Africa, of twin-hull fishing vessels developed by him. He showed films of these boats, and of the boats traditionally used, being launched in heavy surf and returning to shore. He gave details of the performance of the twin-hull vessel and proposed criteria for the operation of small fishing boats in surf which showed that the twin-hull craft had certain advantages.

7. The United Kingdom representative, Mr. A.A.W. Landymore, congratulating Mr. Gifford on his work, read a statement indicating that the British Ministry of Overseas Development, which had financed the trials in Africa, was anxious to assist in furthering this approach by financial or other assistance to Governments of developing countries. This statement was noted with satisfaction.

In the lively discussion which followed, the merits of single and twin-hull vessels were closely examined. Apart from first cost, an important factor appeared to be the number of days' fishing per annum on which the twin-hull vessel could operate.

8. Mr. Pilon, dealing with static structures used in the development of small-scale fisheries, described the types of groyne used in Holland. He stressed the importance of knowing the coast, and of studying the available data, the relevant metereological records and in particular information about wave heights during storms. He noted that more attention was being given today to the special needs of fishery - as against commercial - harbours. He pointed out that wherever possible use should be made of materials that were readily available. He emphasized the value of collecting full data after the completion of works, so that lessons can be learned from any difficulties experienced.

9. Mr. Delap, introducing the fourth Session on mobile and other mechanical structures used in across-beach operations, drew attention to some matters which might not always occur to the designer or operator of slips, and their ancillary equipment - cranes, hoists and the like. He pointed out the importance of making any equipment to be used in small-scale fisheries simple and easy to maintain, and referred to the dangers of giving fishermen a false sense of security, by providing devices which might be easy to use in good weather but which could prove difficult or impossible to operate when the weather was bad and many boats were competing for their use. He referred to some alternatives to costly floating dredgers where the quantity of material to be removed was moderate.

10. Among many contributions by participants during the sessions which followed, Mr. N.P. Bhakta described and produced detailed drawings for several versions of a boat transfer jetty (without decking but with walkways to shore), designed to life boats from the water outside the breaker zone and transport them to dry land or to a sheltered basin. This proposal stimulated keen interest, a number of possible modifications being suggested. It was agreed that trials under operating conditions would be essential.

11. Mr. R. Moor and Mr. M. Breimer described launching and recovery methods employed in Peru and Morocco respectively.

12. Unstable entrances to inlets and estuaries were discussed at length, several promising methods of reducing the cost of maintaining adequate depths in them being described.

13. In addition to those shown by Mr. Gifford, a number of other films and slides were presented during the Consultation:

(i) Mr. van Steenwijk showed a system developed for pumping oil from a vessel lying at a single buoy mooring, which can be used to land fish; he also showed films of a type of anchor designed to be sunk deeply into sand by a water jet, and of the lifeboat service in Holland, which has to meet many of the problems of the small boat fisherman.

(ii) Mr. Breimer presented a film describing a survey and site investigation for a proposed fishery harbour, carried out in India in 1971-72.

14. In the concluding session, the form which the final Report on the Consultation should take was discussed. It was seen to have been concerned with three distinct aspects of small-scale fisheries:

(i) The basic problems to be taken into account in dealing with coastal structure in general.

(ii) The basic problems to be taken into account in dealing with specific projects.

(iii) A general philosophy for assisting fishery projects to be recommended by FAO.

15. It was agreed that the Report should identify and classify:

(i) The problems met in the design, construction, operation and maintenance of small-scale fisheries.

(ii) The solutions, already available or offering promising results, for these problems;

and should contain each of the principal papers presented, and an edited summary of the discussions which followed, including all matters relevant to the subject under consideration.

16. It was agreed unanimously to recommend to FAO that projects should be undertaken, if possible in cooperation with appropriate agencies, in the following fields:

(i) Inexpensive shore stabilizing structures providing some protection against wave action, including improved designs of rubble mound or piled structures for exposed sites;

(ii) Improved energy-absorbing and wave protection structures, floating and fixed for moderately exposed shores;

(iii) Trestle piers, with or without removable decking with mechanical boat-lifting devices - with special emphasis on operational aspects and on the frequency with which these facilities can be used.

(iv) Continuation of the development of improved fishing craft, of a range of sizes, for use on open beaches.

(v) (a) self-maintaining tidal entrances and estuary channels;

(b) the organization of dredging operations to serve several sites;

(c) inexpensive dredging equipment to deal with modest siltation.

(iv) Devices for the launching and recovery of existing or improved craft in across-beach operations.

ANNEX IVa

GOVERNMENT CONSULTATION - ACROSS BEACH OPERATIONS IN THE SMALL-SCALE FISHERY

Summary Paper No. 1: presented by W. J. Guckian, Senior Fishery Industry Officer (Civil Engineer), Department of Fisheries, FAO, Rome.

The small-scale fishery centre: desirable provisions with an identification of those activities which offer most opportunity for improvement

1. Introduction

The fishery harbour complex, whether it be a major facility catering for many large vessels and differing types of fishery, or merely a beach-based unit serving a number of small boats, consists of a more or less similar set of provisions, differing only in the matter of scale.

Should the total annual landings be 200 000 tons landed from distant-water vessels, or 2 000 tons brought ashore by canoes, these landings have to be securely and hygienically unloaded, handled, sold, distributed and processed; the vessels, crews and gear have to be serviced, maintained, repaired and replaced. A lack of any essential provision or service in this chain of activities could cause danger to the economic viability of the whole operation, especially by inability to get the product to the market in a fit state for sale.

2. Desired provisions

Since this meeting is specifically aimed at the small-scale fishery sector (where most of the vessels are less than the 12 m class, and may include a high percentage of smaller, even unmechanized vessels), this paper will restrict its remarks to that sector of the fishery industry. A fishery centre of this type should ideally have the following facilities to serve the fleets catching and landing their products:

(i) A safe spot for craft to unload their catches without loss or damage to craft or landed product.

(ii) A safe location for the craft to lie or berth while preparing (including routine servicing) for the next fishing trip. This might also include a safe haven on land or at sea during seasonal periods of storm, whether of long or short duration.

(iii) An hygienic area under cover of weather, wherein the catch can be cleaned, washed, sorted and prepared for sale.

(iv) A convenient covered or weather-protected location for the actual sales operation, where all buyers can readily inspect the lots on offer.

(v) Areas or housing under cover where buyers can sort and conduct primary processing of the products as required for their customers.

(vi) Water supplies for catch cleansing, vessel servicing, cleansing of general sales hall and other buildings.

(vii) Ice supplies of the appropriate type and quantity to meet the full needs of the vessels and the shore operations.

(viii) Fuel, oiling facility for the vessels and shore machines (where required).

(ix) Gear and container stores and repair areas.

(x) Machinery and engine workshops and spare parts store.

(xi) Boat repair yards and, if required by vessel size, slipway or lift.

(xii) Simple or more sophisticated processing facilities, as demanded by the catch and the marketing needs (e.g. drying, smoking, canning, freezing, meal, etc., and all machinery servicing demanded by these activities).

(xiii) Distribution equipment and its servicing requirements, whether motorised vehicle, cycle or animal-drawn wagons, etc.

(xiv) Road access to the site.

3. Hindrances to the success of the operation

A number of activities or provisions, if not adequately designed to meet the needs of the operations contemplated, could hazard the successful development of the proposed centre. Shortcomings of this nature could occur at any of the following points:

(i) The fishing operation - either through inappropriate craft, gear and equipment, or insufficient power.

(ii) The launching, landing and berthing operations - through inadequately l, constructed or operated craft being unable to negotiate the natural hazards of wind, wave and tide.

(iii) Crew skills - through inadequate on-the-job training for principal crew members.

(iv) Landing and berthing facilities - through either the complete lack of such facilities or the provision of unsuitable or even dangerous facilities for the types of craft being used in the fishing operations.

(v) Shore facilities - even when the catch is landed, all the necessary hygienic handling, sales, sorting, processing, and distribution facilities and services must be provided to enable the catch to obtain its value in the designated markets.

4. Danger spots to be considered by this Government Consultation

The first of these activities - the fishing operation - will be taken care of elsewhere, except where it conflicts with the others, such as the landing operations. Likewise, the crew skills and shore facilities will only have a nominal mention in a few of the Sessions. The principal activities to be considered would therefore be (ii) and (iv):

the launching, landing and berthing operations, and

the landing and berthing facilities.

4.1 The launching, landing and berthing operations

In this group we could include vessels coming from, or going to, the open sea crossing wave plunge zones; entering basins with or without protective breakwaters; or against estuarine currents into, or out of, the river mouth; or through swell to unload and lie at, or to depart from, unprotected jetties; or through swell and surf to ground on, or depart from, open beaches, with or without mechanical or other assistance.

The fields where some improvement in operational conditions could possibly be effected would include:

(i) The provision of a suitable craft to take any or all of these hazards in its stride, while still being a vessel of feasible cost, suitable for the appropriate fishing operation. For instance, a twin-hulled catamaran of the type being experimented with by Mr. Gifford might provide an answer to most of the demands, while a small-sized low-cost hovercraft could be a good across-surf vessel while not being appropriate for the fishery operation.

(ii) The provision of a low-cost effective floating breakwater system outside the wave plunge zone, where transitional forces on the unit would not be too excessive and with minimum anchorage difficulties. In certain wave lengths the "used-tyre-group" breakwater, or even the floating seaweed or papyrus island, if they could be effectively controlled, might provide answers to some of the problems. Pneumatic breakwaters might sometimes provide assistance, but experiments and installations to date demonstrate that operational costs would be excessive for a unit of the type envisaged for the small-scale fishery.

(iii) In certain cases during the fishing season the catches and crews might be able to be hauled ashore by raft or other floating crafts, while the boats are left at anchor and crews and supplies returned through the surf in the special craft.

There are a number of other approaches, for example, providing special motherships of varying kinds to bring the catches to a more protected marketing centre at a distance greater than the effective range of action of the small fishing boats based at the centre.

Many of these solutions directly concern the naval architect and boat-builder with associated help from the civil engineer, while others fall in the civil engineer sector, with help from the naval architect.

4.2 Landing and berthing facilities

It is in this group that the main tasks of the civil engineer lie.

(i) The design, location and operational usage of a landing structure must be examined in detail to provide a more suitable means than now exists to meet the needs of craft approaching an open beach through swell and surf. A berthing operation that would permit landings being made in safety for even a short period of time would answer many demands. Systems to permit longer term berthing for supplying, servicing, and crew recreation, would be even more desirable. Low cost structures that would damp wave and swell, while not interrupting the beach regime with its existing patterns of littoral drift, sedimentation and erosion, would be the ultimate aim in provisions for the small-scale fishery centre.

(ii) Failing such ideal solutions as suggested in (i), low cost means of servicing the craft outside the surf zone by either lifting them out of the water and conveying them safely ashore or, in periods where this is not essential, servicing them and taking crew and catch safely ashore and returning crew and supplies safely aboard again should be sought.

The boat transfer system suggested by the Indian Harbour Project could be one such solution; another might be an adaptation of a boat lift (of the syncrolift type) used with other facilities. An openwork jetty with cranes to lift the craft onto cradles at jetty deck level to transport them to a safe boatyard might be a good solution for a certain limited sized boat. An inverted V-sloping pier or ramp system over a sandspit into a lagoon used elsewhere (South Australia and Guyana) for other reasons might be adapted in some situations.

5. Conclusions

It is not expected that one solution could be determined to satisfy all site characteristics. Groups of proposals to meet the demands of specific site conditions might be suggested and, if more detailed examination proved them to be feasible, they could be experimented with under suitable conditions as pilot projects or even as first-phase developments for later extensions in more extensive projects.

ANNEX IVb

GOVERNMENT CONSULTATION - ACROSS BEACH OPERATIONS IN THE SMALL-SCALE FISHERY

Summary Paper No. 2: presented by Professor Per Bruun, Technical Univeristy of Norway.

Consideration of coastal engineering problems affecting the development of small-scale fishery operations

1. Introduction

In practice one should distinguish between shores with a littoral drift and shores without drift which mean rocky shores. There are two types of shore with littoral drift. One is the open shore with littoral drift, the other is the tidal inlet or estuary shore where a channel connects the exposed littoral drift shore with a bay or a lagoon or where an estuary connects the ocean with a river.

2. Open shores with a littoral drift

Most shores in the world belong to this category. They are exposed to wave action which causes a littoral transport along the shore. Wave action, thereby littoral transport, may be of seasonal nature.

Wave action across the nearshore shallow zone may be so severe that it is detrimental to operation of boats across the surf zone and the littoral drift makes maintenance of a navigation channel across the nearshore zone very difficult or even impossible.

Protection against wave action may be arranged by breakwaters which, however, will constitute full or part littoral drift barriers causing problems of shoaling as well as erosion. Practical experience has shown that it is very difficult to cope with these problems in an economic way. A few "Island - harbours" have been built by erecting harbour structures in the open sea outside the outermost breaker zone and connecting these structure with the shore by an open pier. Such offshore harbours, however, tended to connect themselves with the shore by accumulations (tombolos) causing problems to the harbour itself as well as to adjoining shores particularly on the downdrift side.

More modest size layouts have been more successful. What is demanded from such installations include:

(i) stabilization of the shoreline;

(ii) steeper nearshore profiles making landing operations easier;

(iii) some protection against wave action;

(iv) a widening of the beach providing landing and storage areas for boats; and

(v) an economic solution with low initial cost and absolute minimum maintenance costs.

TABLE I

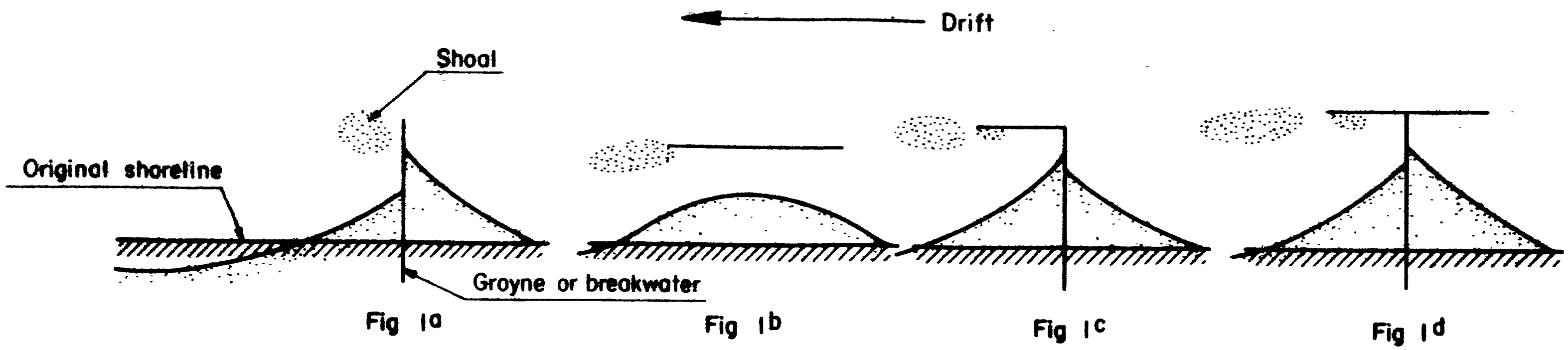


	Fig 1a	Fig 1b	Fig 1c	Fig 1d
STABILIZATION OF SHORELINE	B	B	A	A
STEEPER PROFILES	B	B	A	A
WAVE PROTECTION	D	B	A	A
PROVISION OF SPACE	D	C	B	A
ECONOMY	A	B	C	D

Table 1, figures 1a to 1d show in plan various installations fulfilling the above-mentioned demands in varying degrees.

Fig 1a is a single groyne or breakwater extending perpendicular to the shoreline. The expected development of accumulation and erosion is shown.

Fig 1b is an offshore breakwater.

Fig 1c is an angular breakwater or groyne combining Figs 1a and 1b.

Fig 1d is a T-breakwater or groyne.

In Table 1 relative grades A (best) to D (poorest) are given with respect to the ability of the various layouts in fulfilling the requirements listed above.

One may see the relative "efficiency" or "ability" and the economy are in inverse proportion.

Details of layouts and structures depend upon the physical characteristics and general requirements of the case in question. In all cases, the installations may be improved by winches or other mechanical gears making transfer of boats across the beach and nearshore zone easier.

One severe problem associated with any of the layouts shown is the interruption of the littoral drift which may cause erosion on the downdrift side and may also cause shoaling problems on the downdrift side expanding further downdrift unless bypassing of sand is undertaken - and this is usually impossible for reasons of economy in the small-scale fishery sector. A certain amount of natural bypassing, however, usually establishes itself and downdrift-side erosion may be tolerated on relatively uninhabited shores. It also happens, however, that such installations are entirely "buried" in sand.

On many shores (e.g., on the Pacific, frequently on the Atlantic and on both east west shores of India) natural outcroppings of rock function as groynes and breakwaters and have thereby established landing places. At some places it is the updrift (exposed) side which offers the best possibilities due to its higher steepness. At other places and mainly on the most exposed shores like the American Pacific headland shores and on the Indian Arabian Sea, it is the downdrift, more protected side which is useful as landing place for boats.

In practice it will sometimes be possible to improve such natural headlands or outcroppings and the same is true for offshore reefs. In the tropics, coral reefs very often present such opportunities.

With respect to the actual dimensions of the improvements shown schematically in Table 1, it is, needless to say, important that they have sufficient size to avoid soon after completion their complete burial in sand requiring almost immediate and continuous maintenance works. In this respect one must be guided by knowledge about quantities of drift and by experience from elsewhere under similar conditions of profile geometry, orientation of shoreline and wave exposure.

Fewer mistakes can be made, however, if one starts with the solution Fig 1a extending the groyne in steps until a satisfactory solution is obtained. After that, one can also better evaluate the further need and advantages associated with an addition of cross members. This does not mean that it is not possible to design beforehand such project and make proper plans and estimates but it is rather a practical construction procedure permitting a full-scale test. If the situation develops according to plan while the work progresses, the project is completed as scheduled. If not, it is possible to make adjustments.

3. Open shores interrupted by tidal inlets or by estuaries

Tidal inlets on littoral drift shores as well as estuaries often offer excellent opportunities for the establishment of ports and particularly ports for relatively shallow-draft vessels. The difficulties lie in keeping a stable ocean channel.

Comprehensive studies have been undertaken in relating inlet stability including channel cross section and geometry to flow parameters as well as to littoral drift quantities. It should in this respect be emphasised that flow as well as drift are seasonal parameters and that stability therefore varies with the season particularly in areas with monsoons and similar seasonal phenomena. The results of these studies are that the great majority of tidal inlets on littoral drift shores have unstable channels and most often also bars and shoals for which reason they have to be improved by jetties and/or maintained by dredging. "Tidal Inlets and Littoral Drift" (copies of which are available to the meeting) is a recent paper on this topic and it may easily be realized that most inlet improvements and installations for bypassing of material are too expensive to be justified for the very great majority of fishing port or fishing facilities on the open shore. If inlets are large or improved for shipping in general, they usually offer good opportunities for the establishment of fishing ports.

The same is true for estuaries if the volume of flow is large enough to keep at least one channel relatively free of deposits. Density currents usually play an important role with respect to siltation in estuaries and it is often very difficult or impossible to change nature's regimen. Certain channels may, however, by means of training walls be arranged for almost unidirectional flow, particularly for ebb currents which may be beneficial to stability.

4. Across drift zone operations

As any structure placed in the littoral drift zone will interfere with the drift and work as a whole or part littoral drift barrier and as the main littoral drift zone is the breaker zone it is obvious that it would be an advantage if this zone could be "bypassed" or "overpassed" somehow without interfering with it. Attempts in doing this include:

(i) Winches, e.g. of the type which has been in use on the Danish North Sea coast.

(ii) Open straight trestle piers with no head. Such piers, extending across the breaker zone, may be built with a light or a heavier deck. In the case of the former, light boats like canoes may still be lifted up on the pier in slings by hand-operated winches and transported along the pier. Heavier piers may take light cranes and various kinds of carriers or trollies for lifting and transport of heavier boats on the pier. Heavier piers may also be built with T heads providing more berthing or landing space in deep water. If such heads shall also give some shelter for boats on the inside they will have to be rather long, at least 100 metres and of a sturdy design. Reflection of waves from the seaward side could then make that side less useful and the entire structure will become expensive and hardly justified as a structure for fisheries.

(iii) At several places in the world wave action is very seasonal such as in the monsoon regions like India and Southeast Asia. The calmer periods with a relatively small swell action are the longest and this may justify the use of special pier installations where boats are stored on the beach during the three to four months stormy season and spend the rest of the year moored at a pier. This pier may be provided with a gantry crane at the extreme end which picks up or launches the boats and places them on trollies or other kinds of carriers which transport the boats to or from the storage area.

The decking of the piers may be very sturdy or removable to avoid damage during ext wave conditions.

ANNEX IVc

GOVERNMENT CONSULTATION - ACROSS BEACH OPERATIONS IN THE SMALL-SCALE FISHERY

Summary Paper No. 3: E.W.H. Gifford, B.Sc. (Eng.), FICE, FIStructE,
Senior Partner, E.W.H. Gifford and Partners,
Southampton, England

A Note on the Location and Planning of Fishing Terminals for Smaller Craft

1. Introduction

The provision of comprehensive facilities at terminals catering for the smaller fishing craft, which has been rarely done in the past, is now likely to be more widespread because of increased interest in improving the working conditions of the artisanal fisherman.

This note sets out the various factors which must be considered and suggests some solutions.

2. Experience

The author bases his views on his experience in working with, and designing for, the inshore fishermen of the south and west of England, together with similar acquaintances with the fishermen of parts of West Africa.

3. Factors to be Considered

A successful fisheries landing place and market must satisfy the following conditions:

3.1 Proximity to fishing grounds

The terminals must be as close as reasonably possible to suit ble fishing grounds. A modern freezer trawler is an expensive cold store, whilst in a small boat the catch rapidly deteriorates. The economic return on manpower is less in small boats than in large, even though the return on investment may be greater, so the fishermen must spend as much time as possible in fishing, not travelling between landing place and fishing grounds.

3.2 Safe landing and good protection at low cost

This may be achieved in a number of ways:

3.2.1 Use of natural inlets and river mouths: Where these can be used without maintenance dredging, then this is obviously the best solution.

3.2.2 Construction of protection works: If existing natural features, which themselves give insufficient protection, can be improved by the skilful addition of relatively minor engineering works, then this is also a good solution, provided subsequent erosion or silting does not result.

The construction of major protection works must be considered with great caution. The initial cost of such works must be met by grants in such a way as not to place a substantial burden on the fishing industry. Experience indicates that landing dues on fish cannot be expected to meet more than one quarter the cost of major protective works.

Any scheme which involves substantial maintenance dredging must be avoided unless the cost of this is to be met outside the fishing industry.

3.2.3 Design of special boats: In many parts of the world, special boats have evolved to land in difficult situations - the African beach canoe, Yorkshire coble, Irish curragh, Hastings lugger, to name a few. One particular development of this type is dealt with by the author in another paper at this Conference - "The development of the CATFISH surf beach combination fishing boat".

3.3 Proximity to markets other than local

If there is to be any purpose in a development intended to encourage subsistence fishermen to increase their catch, then they must have reasonable access to expanding markets. Given this access then, in most countries, the activities of the fish merchant will generate a demand for fish in good condition.

The access can be of many forms, the most usual is by road, in which case the transport is simple and straightforward and distances can be long, 50 to 100 miles on a good road is not a problem if there is a good source of fish and a good market. Sometimes access is by inland waterway and this must reduce the effective distance very considerably, perhaps to one quarter of that of road haulage unless special refrigerated river launches are to be employed, which would only be justified if catches were large and regular.

If high value shellfish are involved, then more exotic forms of transport are sometimes used. Lobsters caught in curraghs off Ireland are flown by jet to Paris, but this cannot be regarded as a common situation.

A good example of the balance between sea-time and transport is given by the recent experience of some fifty boats fishing for mackerel out of Falmouth in Cornwall, England. These are two-three man boats about 24-30 ft long, using gurdies on a large pelagic shoal which is sometimes within a 30 min journey of the landing place. The fish is then loaded into large refrigerated trucks onto a ferry between Plymouth and Roscoff in France where the fish is canned, a journey of 50 mi by land and 120 mi by sea.

This operation is an economic success, but it would not be if the small-boatmen attempted the long sea journey direct to France.

3.4 Proximity to existing settlement

It is being increasingly realized that the movement of population is socially undesirable. It is, therefore, generally getter to develop a site near to existing fishing villages rather than develop a virgin site, particularly if the upgrading of these villages is an objective. It should, however, be noted that some fishing communities, such as the Ewe in Ghana, are accustomed to move in pursuit of fish, but this is a seasonal movement and the home village generally remains as a base.

3.5 Availability of good water and reliable electric power

If a good quality produce is to be achieved, then an adequate water and electrical power supply must be assured.

4. Facilities to be Provided

The traditional markets are simple open spaces often without pavement or roofing. In such places, the catch suffers rapid deterioration and is not suitable for dispatch to distant markets. Even smoking, when carried on under similarly primitive conditions, does little more than impart a flavour that disguises the deterioration of the catch.

For improvement in marketing and trade, the catch must be sold in prime condition and this means rapid handling, protection from sun, cleanliness and ice.

In turn, this means that the layout of the terminal must be such that the catch can be rapidly transferred from vessels of many sizes, directly into a covered market with a paved floor which is washed down daily. Facilities must be available for sorting and display and for accommodation for auctioneers and buyers.

The transfer from market into cold store and into transport must be equally direct.

The terminal must, therefore, be laid out so that the market building must be immediately alongside the quay or landing place, as near as possible, so that baskets of fish come out of the insulated fish hold or container straight under the cover of the market hall.

The road or inland waterway must be adjacent to the opposite face of the market so that the packaged fish, preferably in ice, can pass directly into the transport vehicle.

4.1 The facilities needed are therefore:

(a) A market building with insulated roof and good doors, paved floor with high pressure hoses and proper drains. The building must be as close as possible to the landing place.

(b) An ice plant of adequate capacity. Storage hoppers may be used to reduce the size of the ice-making plant, but these require careful use, particularly in tropical conditions where even well insulated hoppers should not be expected to store for more than 24 h.

(c) A pure water supply is essential to the use of ice. If this is not available, then it is better to use improved smoking methods.

(d) Repair facilities. These must be appropriate to the boats and gear used. Traditional fishermen can repair their canoes and nets and must learn to be equally competent with modern equipment, given suitable back-up on such specialist matters as engine overhauls. Slipways, welding and simple machine shops must be provided and men trained to use them.

5. Planning of Terminals

This can be very complex, as it is essential to get the best possible balance between the varying components. Traditional societies evolve through trial and error of many generations and their equipment and village layouts are often very efficient within the limits of their technology.

A new facility that scatters its components at random will not work well and may fail.

The development of an existing primitive community is particularly delicate in that the majority will for some time wish to pursue the old ways with existing canoes and nets, but they must be given a good access to the new terminal even though their requirements may be different from the owners of new types of inshore boats.

6. Location of Terminals

The assessment of the best location of a terminal can be a difficult matter for, as previous examples have shown, quite unlikely factors can influence the choice.

But as proximity to fishing grounds and existing communities are the most important factors, then it is quite likely that sites with good protection may have to be rejected in favour of more open or "difficult" conditions.

7. Conclusion

In the upgrading of existing fishing communities by the provision of improved landing facilities, it may be that the site offering the best natural protection is not the best economic choice. Hitherto the assumption has been that if beach fishermen wish to improve their trade, then they must move to some creek or inlet where larger boats can be used. But if such a site is remote from fishing grounds, the existing villages or rewarding markets, then it may be better to develop the existing beach site either by careful civil engineering works or by specially designed boats.

It must always be remembered that it is the total operation of catching, landing, processing and selling that must be a success and not merely the provision of adequate protection.

ANNEX IVd

GOVERNMENT CONSULTATION - ACROSS BEACH OPERATIONS IN THE SMALL-SCALE FISHERY

Summary Paper No. 4: presented by E.W.H. Gifford, B.Sc. (Eng.), FICE, FIStructE, Senior Partner, E.W.H. Gifford and Partners, Southampton, England

The Development of the Catfish Surf Beach Combination Fishing Boat

1. Introduction

As a result of their studies of the problems of the fisheries of developing countries, the civil engineering firm of E.W.H. Gifford and Partners have concluded that there are certain open beach landing situations which would be better solved by the development of special vessels rather than the construction of civil engineering works.

2. History of Development

The Catfish project originated at the Conference on Fishing Ports and Port Markets, organized by FAO at Bremerhaven in 1968, when many delegates from developing countries expressed the need for improvement of the fishing capability of artisanal canoe fishermen working from open beaches for the construction of harbours to facilitate this.

But the construction of normal harbours on open beaches subject to littoral drift can have not only a high first cost but also high maintenance dredging costs, so it was considered by the author that a better solution would be to design surf boats of such size that a small trawler or seine or gill netter could operate through surf onto the open beach.

A good deal of work has been done by FAO and others to provide alternatives to the canoe; these appear to have been light, open boats intended for manhandling on the beach.

It was thought by the author that if power winches, skids and rollers were to be used, then a larger vessel could be launched and recovered as is already done at Hastings and Yorkshire in England, and at Jutland in Denmark. At these sites, however, the boats do not operate through surf of the same magnitude as is characteristic of the open coasts of the problem areas. The boats used are mono-hulls which would broach and swamp, or be heavily pounded in large surf.

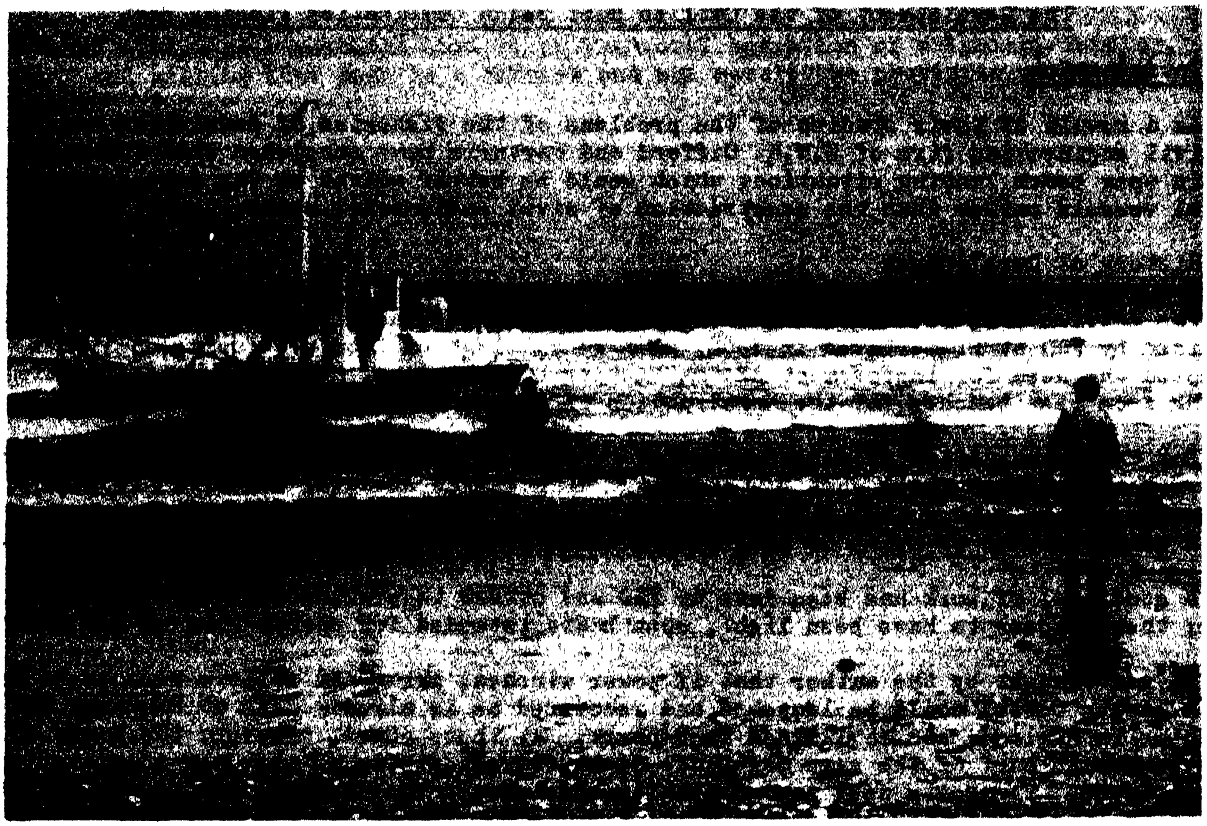
The design problem was to evolve a craft of great stability, good fishing power and very shallow draught. The use of a very beamy, shallow mono-hull might not give a good motion at sea and would still be liable to capsize on broaching.

An investigation was accordingly made into the possibility of using a twin-hulled or "catamaran" design. This appeared to have the possibility of combination of great stability, shallow draught and good sea-keeping ability.

Accordingly a series of model tests were instigated, starting at 1:12 and working up to half full-size. As these were very satisfactory, a full-sized craft, 38 ft long x 20 ft beam, was built by E.W.H. Gifford. This vessel has bottom and sides of aluminium with decks and wheelhouse of marine plywood. Each hull has a Lister SR3 engine developing 19 bhp. A "Fifer" Junior Capstan is driven off one engine.

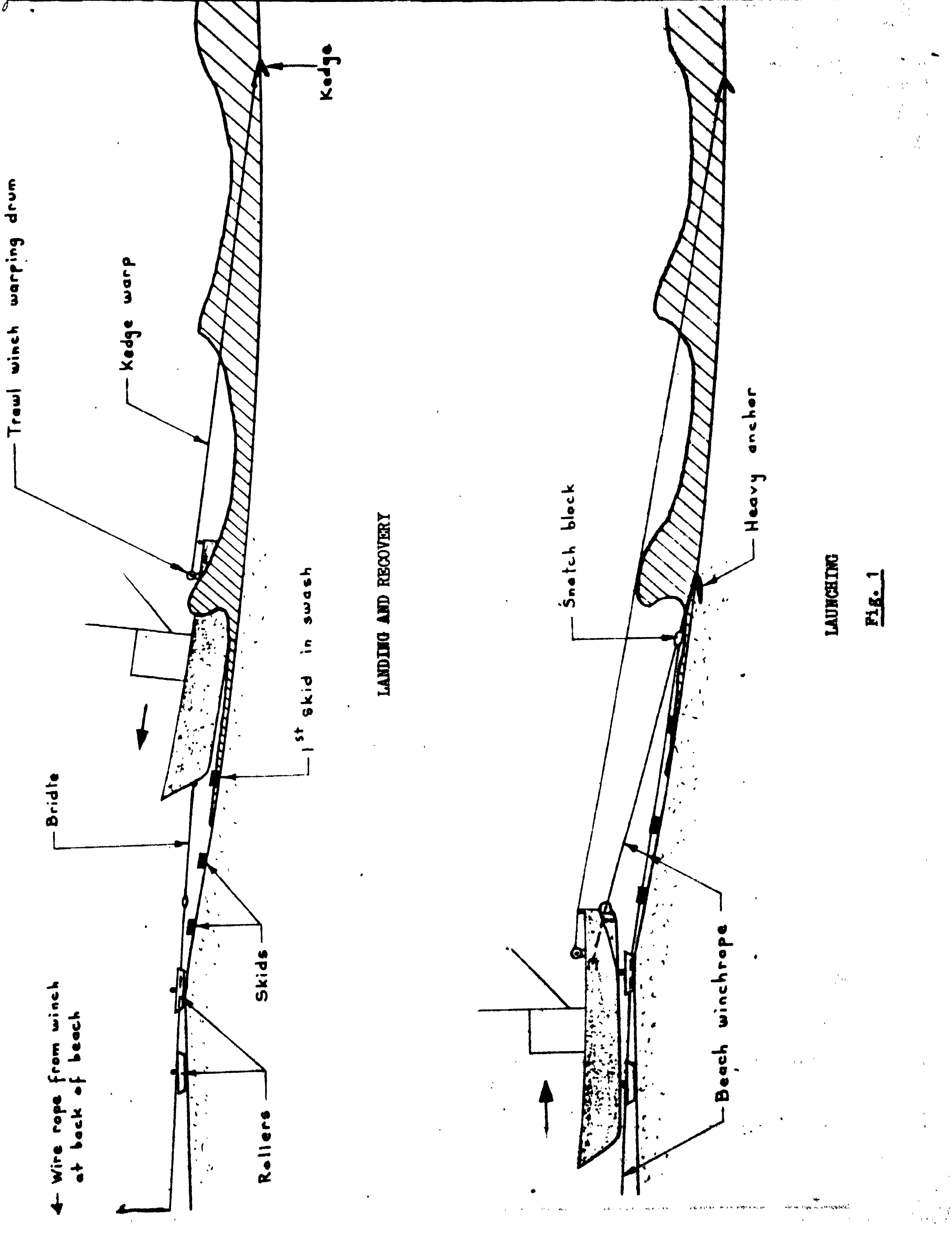
This boat called CATFISH was bought from E.W.H. Gifford by the British Ministry of Overseas Development and presented to the Nigerian Government for use as a research project.

Landing and fishing trials were carried out by the Western State Fisheries Department at Lagos, and later at the Aiyetoro Community.



CATFISH II under test

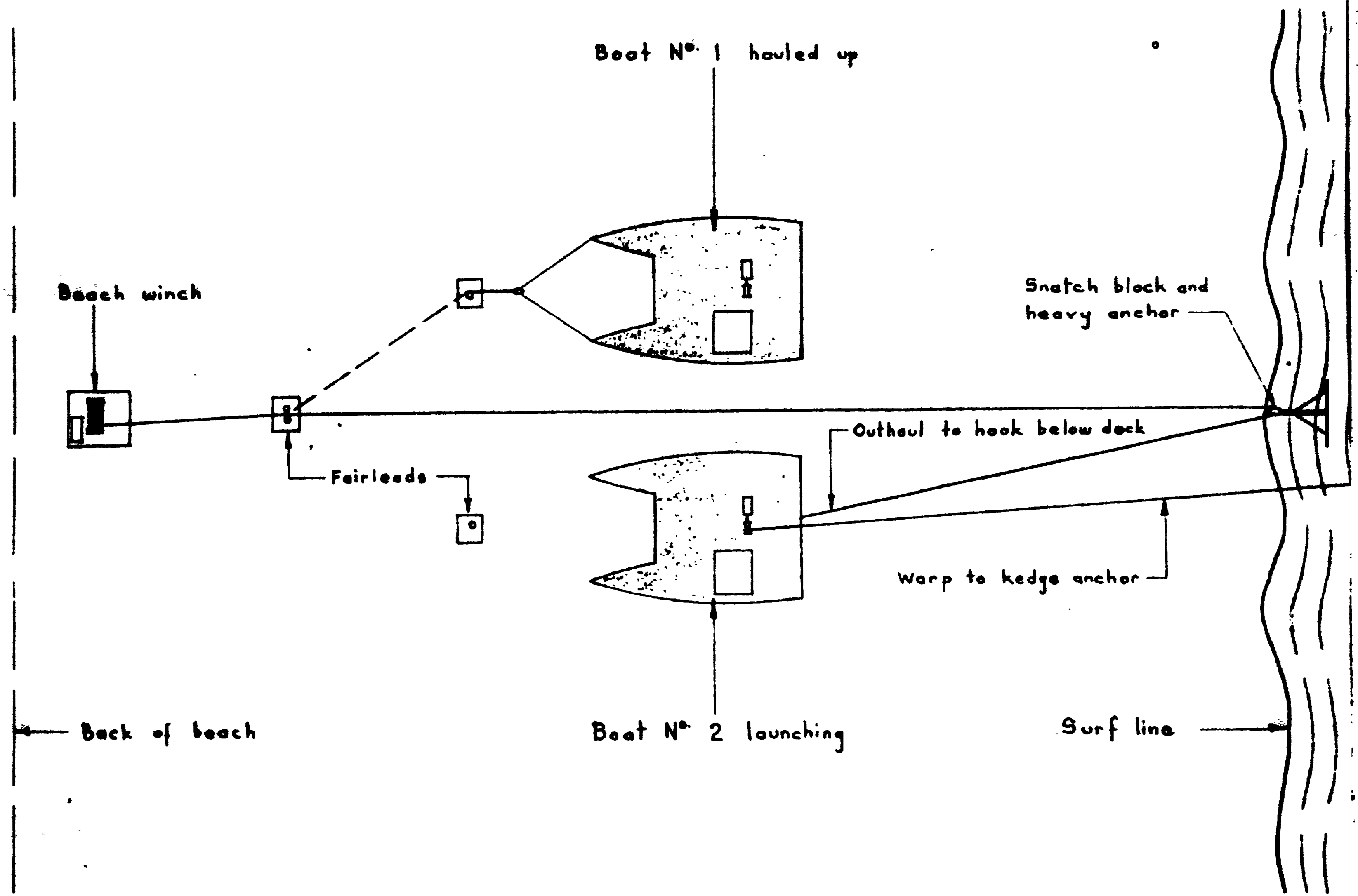
[Photo: E.W.H. Gifford and Partners]



LANDING AND RECOVERY

LAUNCHING

Fig. 1



DIAGRAMMATIC BEACH LAYOUT FOR TWO BOATS

Fig. 2

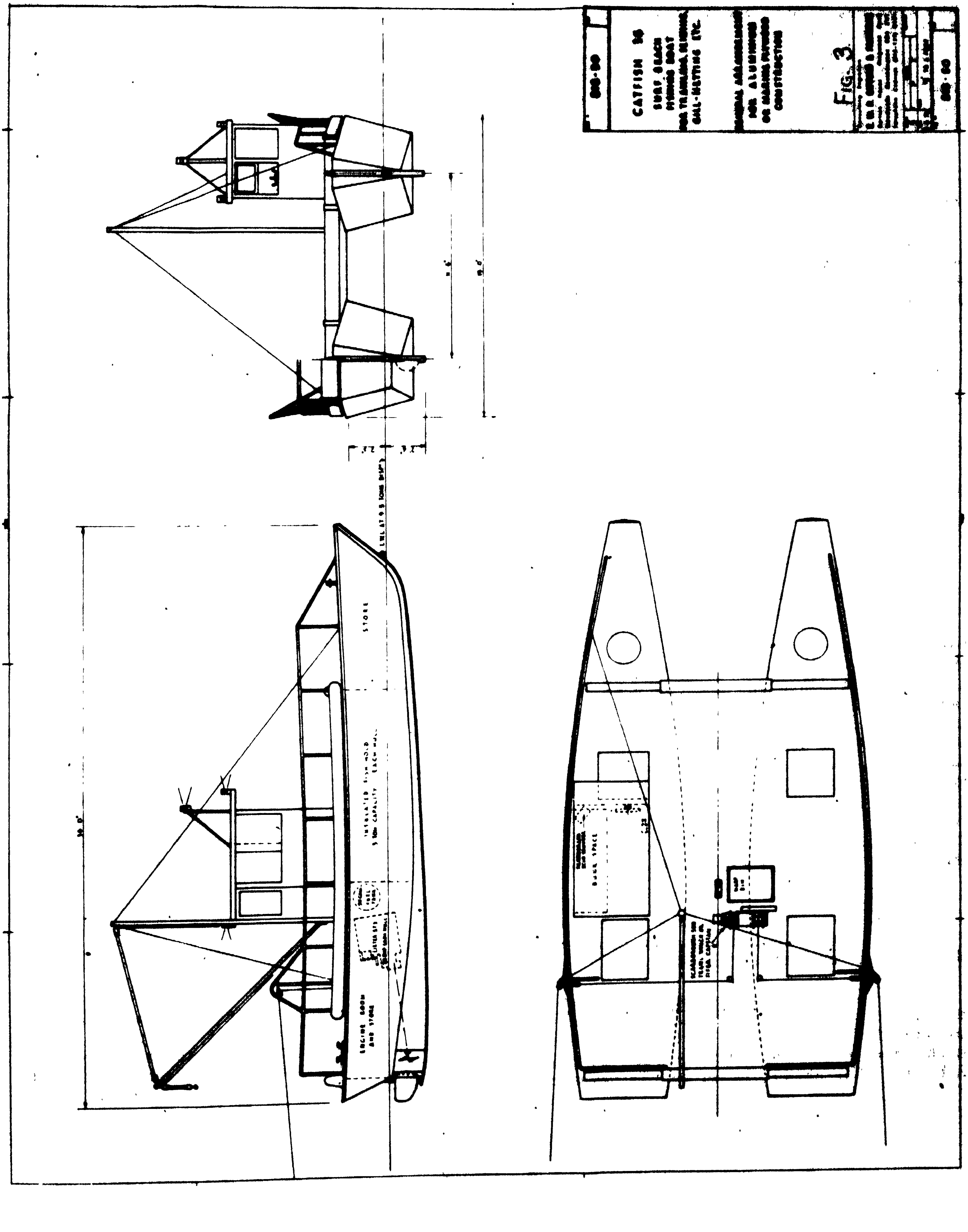


Fig. 3

These trials were satisfactory, showing that not only was CATFISH capable of landing on, and leaving, a surf beach, but also provided a good fishing platform, having a large area of deck and a very steady motion in a seaway.

The ample space enables two different sets of fishing gear to be carried on deck at the same time so that, for instance, the boat can set out in the morning with a half-mile of gill nets on deck forward and a trawl aft. The nets can be shot and the boat can continue trawling until evening when the gill nets can be recovered before landing.

It has been encouraging to learn from the many experienced fishermen who have worked with CATFISH I and II that they consider them to be efficient fishing boats in their own right, regardless of surf landing capability.

Many developing countries would wish to build their own boats using their most readily available material, timber. Accordingly, a second boat, CATFISH II, was built entirely of marine plywood on iroko frames. A new, more powerful, version of the Lister air-cooled SR3 is now available, called the ST3, giving 28 bhp. These have been fitted in CATFISH II and enable a 7 fath head-rope trawl to be towed at 2-3 knots. Other improvements are the fitting of a twin-drum trawling winch and insulated fish holds. Trials have shown the timber construction to be entirely satisfactory from the point of strength, but the scantlings used were large and resulted in a boat weighing 7 tons, as compared with 5 tons of the part-aluminium CATFISH I. It is also considered that the 38 x 20 ft overall dimensions are larger than needed and a revised design of 36 x 19 ft has been produced, as shown on drawing No. 818.50 (Fig. 3). This design can also be built in marine plywood with glass-fibre sheathing which would be suitable for local construction. But for those countries that are aluminium producers, or who have funds available for purchase of aluminium parts abroad, it is considered that the greater life of this material would be attractive.

3. Beach Handling Technique (Figs. 1 and 2)

3.1 Landing

On approaching the beach, 1 30 lb Danforth kedge anchor is dropped outside the surf line and a 2 in circumference nylon warp paid out as the boat runs in. No tension is put on the warp until the boat grounds on the beach when it is used to prevent the boat swinging sideways in the swash. It should be noted that as the draught is less than 2 ft 6 in, the boat passes through the heavier surf before contacting the beach, thus the actual impact of landing is small. With the warp tightened on the warping drum of the winch to hold the boat straight, it rests steady in the swash whilst the cable from the beach winch is secured to the ring of the steel rope bridle which is permanently shackled to ring bolts in the stems. Ballasted greased timber skids are then placed under the bows and the winch commences hauling the boat up the beach, additional skids being inserted on the way. The stern warp is slacked away as soon as forward motion commences. Just before the boat arrives at its final position at the top of the beach, a set of rollers can be placed under each bow, and the boat hauled onto these to facilitate launching and to prevent "freezing" onto the timber skids. The kedge warp is then secured to its deck cleat.

The technique depends on the slope of the beach and nature of surf and needs to be adjusted for individual sites.

3.2.1 Steep beaches (1:7 or steeper): This is the simplest case as by a combination of the steepness of the beach and the rollers, the boat will launch itself upon release of the cable slip on the beach winch. A track of greased skids must be laid first as the boat will move with some speed, particularly after the keel bands have become polished with use. The skids placed in the swash must be ballasted.

With steep beaches, the surf generally breaks near the beach, and so the boat passes quickly through it, aided by hauling in the kedge warp with the trawl winch-warping drum.

If there is difficulty in moving the vessel, the kedge warp can be used to give a pull of 1/2 a ton, but this is insufficient if the beach angle is flat or the keel bands are rusty or the rollers ineffective. Loads up to 3 tons may then need to be applied.

3.2.2 Flatter beaches (1:7 or flatter): Two problems arise here, the first to move the boat down the beach until it is floated by the surf, and the second is the time taken to pass stern first through the surf when this is breaking far offshore.

The 30 lb kedge anchor can only resist a 1/2-ton pull and it is inconvenient to drop a 500 lb anchor beyond the surf line.

The heavy anchor is therefore placed as far down the beach as possible at low tide and a snatch block attached to it. The beach winchrope is led round the snatch block and back to a heavy steel hook on the underside of the deck. Thus the boat is winched down the beach until floated by the surf, when the kedge warp will pull her clear. The boat cannot be launched at low tide by this method. If this is necessary, or if there is a small tidal range, the heavy anchor will need to be carried a little way offshore between two canoes. As this would make subsequent recovery and maintenance difficult, this would not normally be done.

The second problem of passing through offshore surf is overcome by turning the catamaran in the smaller inshore surf, by going ahead on one engine and astern on the other. It is better to drop the kedge warp (the end being made fast ashore) rather than recover it when manoeuvring in this way. The anchor end of the warp must be buoyed so that this can be picked up before landing.

3.2.3 Simpler gear: The above techniques are dependent on the use of a powered beach winch. This is not an expensive item, being less than one-tenth of the cost of the boat and being able to serve two boats or more. Nevertheless, for smaller and cheaper boats, simple gear would be a greater economy, and experiments are being made with hand-cranked winches and also with multiple tackles hauled by the trawl winch-warping drum.

3.2.4 Summary: Whilst the experience so far obtained is satisfactory, it must be realised that this is only the beginning of a new technique which will inevitably evolve more refined methods with further practice.

ANNEX IVe

GOVERNMENT CONSULTATION - ACROSS BEACH OPERATIONS IN THE SMALL-SCALE FISHERY

Summary Paper No. 5: presented by H.A. Delap, BE, FICE, F.IEI, Dublin, Ireland

...ts on the subject of the Meeting, and t...
...idelines for identifying the var...
...blem under considera...

1. The Basic Problem

How to get a fishing boat and its crew from safety to sea, and back again with its catch. Safety at sea is not a problem peculiar to across-beach operations and so need not enter into our present deliberations (except to the very important extent that any solutions that we propose for the cross-beach problem must not add to danger at sea - some device, for example, which makes the boat less seaworthy can hardly be advocated without serious warnings - perhaps not at all).

2. It is assumed that the phrase "Across-Beach Operations" in the title to the Meeting is intended to include not only (a) the beaching and hauling up of boats to dry land, but also (b) their entry by a channel into a basin where they can lie safely afloat. On this assumption we have, in fact, to try to solve two quite separate problems - although both problems might be met at a single site (and at that site neither might be found capable of solution).

3. The first method - beaching and hauling to safety on dry land - is likely to take up the larger part of our attention, since it is the more common practice, simply because there is a great deal more open beach than accessible sheltered water along the world's coastlines. Also any solutions to the problem of beaching and hauling up (or ways of easing that problem) are more likely to have a general application. Channels into basins tend to present problems and attract solutions, at least some of which are applicable only to a particular place. Nevertheless, we must do all we can to find means of improving both operations.

4. Handling the catch is an important activity, but it falls within the terms of reference of the Meeting, I suggest, only if handling is from the catching vessel, while still afloat, to the collecting vessel or other means of transport. If the catch is brought in with the boat, handling becomes a land-based problem, not peculiar to across-beach operations.

5. Beaching and hauling up the boat is, of course, only one part of an operation. The boat must also be hauled down, floated off and taken safely to sea. The first part, however, raises more problems and anxiety, since the operation begins with the boat in a situation of potential danger - weather and sea conditions may be deteriorating or night approaching - and something must be done; the problem will not go away. Launching, on the other hand involves leaving safe conditions and can be postponed if the operation proves difficult or conditions seem too hostile. Again, a solution to the landing problem is likely to bring us a long way toward making it easier and safer to take a boat to sea.

6. The problem of improving the operation of beaching and hauling up can be approached from several angles, by attempting to improve

the boat;
the equipment for handling the boat;
the technique used; and
the

The programme for the Meeting takes account of each of these possible routes to a solution. Certain points seem worthy of attention when looking for improvements along the three last-mentioned routes. Mr. Gifford has already done valuable work in the development of an improved boat, and it is very much to be hoped that this work can be continued.

7. Equipment for Handling the Boat

In designing any equipment for general use in small-scale fisheries - for example boat-cradles - low cost, reliability, sturdiness, simplicity and ease of operation are clearly of great importance. Any elaborate equipment calls for careful maintenance, which means a person specifically and clearly responsible for the condition of the equipment and readiness for use at all times. This raises a matter of some importance. The man responsible for maintenance of the equipment is likely to be the person in control of its operation. He must, therefore, be not only reliable and technically competent, but also completely impartial and able to inspire confidence and avert panic when the equipment has to be used in difficult or emergency conditions.

All one-boat-at-a-time devices, such as cradles, hoists or cranes, have a fundamental disadvantage in common. At the time when they are most needed, their operation becomes most difficult. An operation such as locating a boat on a submerged cradle can look (and can be) very simple and safe in good weather and with plenty of time. In conditions of rough water and rising wind, possibly in darkness, with a queue of boats demanding quick attention in the knowledge that the sea is worsening, the simple operation can easily break down, resulting in panic, loss of boats or lives, not to mention damage to the equipment. This is less likely to happen if the man in charge is experienced, calm, fair and firm to all comers. The discovery and appointment of such a man presents a major problem.

As a means of refuge from the sea, the infinitely wide slip, that is to say the open beach, has much to recommend it. Its capacity is unlimited and each individual handles his own boat, if necessary at the same time as his fellow fishermen. This suggests the desirability of using cradles designed to run on sand rather than on rails; they would provide many of the advantages of open beach landing, and should ease the task of hauling up the boat. Cranes or hoists are attractive to the engineer; they are the means by which he normally lifts things. Attachment of a heavy hook or a complicated sling to a rolling or pitching boat - again in worsening sea conditions and growing darkness - without injury to boat or crew, makes the use of a crane, to say the least, unpromising. In considering such solutions, and in fact in dealing with nearly every aspect of the whole problem, the engineer must be, or must be closely associated with, a practical seaman.

8. Improving Techniques

Improvements in technique may emerge with trials of successful new craft or equipment. It seems unlikely that techniques which have evolved over many years, perhaps centuries, will be capable of much improvement unless improved equipment or boats become available.

9. Improving the Environment

Improving sea conditions, so as to make beaching or launching easier and safer, is an attractive idea. For example, some form of breakwater, whether solid, permeable, floating, submerged or pneumatic, might be used to provide some local shelter which would protect a slip. This, however, seems an unlikely solution at a cost appropriate to a small-scale fishery. Questions of reliability and of maintenance also arise. Nevertheless, some research seems desirable.

10. Safe Basins in which Boats can be Afloat

This, the other main solution to the problem of cross-beach operations, will be less common since it requires the existence of a natural basin, whether estuary, lagoon or lake, or at least a convenient depression which can be made large enough and deep enough by the

removal of soft material and which will not fill up rapidly with sand or silt. A convenient entrance channel must also exist or be easily dredged and maintained. Heavy maintenance dredging of the channel, likely where there is significant littoral drift or deposition of river-borne material, will rule out any such solution for the small-scale fishery.

Fixed works, designed to maintain depth in a channel by cutting off the source of accreting material, may seem attractive, but experience suggests that if the depth to be maintained is significantly below the natural depth, it will usually be cheaper to dredge rather than to build and maintain fixed works and service their capital cost.

Fixed structures, and indeed regular dredging to maintain a channel, may cause or aggravate erosion on the down-drift side of the channel. Consideration should be given to disposing of any dredged material where it can counteract the erosion by feeding a wasting beach. Such a procedure may, in fact, be cheaper than dumping the material out at sea.

Alternatives to orthodox floating dredgers, such as land-based excavators or pumps, perhaps mounted on gantries and retractable in bad weather, seem worth consideration and research. Mr. Bruun has indicated that there have been Danish or Dutch experiments and model tests, while other research may well have been carried out elsewhere. Results from as wide a variety of sources as possible should be sought. Any improvement found possible could have a wide application.

11. Protection of Entrance Channels

The ideal entrance channel, apart from being self-maintaining, would be naturally protected from the sea and would be easy to enter in the worst weather. If artificial protection is needed, its cost is likely to be prohibitive, though if promising results were obtained from the investigations suggested in paragraph 9 above, they might be applicable here also.

12. Basins used by small fishing boats in Ireland, approached by quite a short channel, and too small to provide adequate stilling of waves, have been successfully protected, at acceptable cost, by removable booms - large square logs dropped into slots to block the mouth of the basin. These are much cheaper than any form of gate and are adequate for their purpose, which is to keep out waves - not water.

13. Such a device must be used with caution. It must be sufficiently protected from direct wave action to be safe from possible damage, and to make it possible to defer erecting the boom until weather has deteriorated significantly; otherwise it becomes necessary to close the dock so early that boats seeking shelter will arrive too late to be allowed entry. It is, therefore, essential that the provision of such a dock should not be allowed to create a false sense of security. Its limitations must be stressed, both before it is built and repeatedly afterwards. Finally, its entrance should be so sited that a boat arriving too late for admission can withdraw to sea safely and ride out the storm or seek alternative shelter.

14. The earlier report - FAO Fisheries Technical Paper No. 136 - sets out (page 17, paragraph 3) a list of subjects for future study. This list includes nearly every aspect of the main problem to which these notes have referred, and one or two which do not come strictly within the scope of across-beach operations. This list seems, therefore, to be an admirable summary of what further activities this Meeting might hope to set in motion.

ANNEX IVf

GOVERNMENT CONSULTATION - ACROSS BEACH OPERATIONS IN THE SMALL-SCALE FISHERY

Paper presented by R. Moor, Project Manager, Fishery Harbour Development Project, Lima, Peru; and M. Cabezas, Chief of Engineering Office, Ministry of Fisheries, Lima, Peru.

Across Beach Landing in Peru - June 1975

1. General Information

Basically there are two kinds of beach landings in Peru. The first is practised north from Talara (see Map 1) and is not really a beach landing. The boats anchor beyond the breaker zone, and the fish is transferred in baskets to small wooden platforms which are brought in through the surf. At most of these places fishery harbours are technically possible, and could be provided at a few selected sites, if funds are made available.

The beach landings related directly to the subject of this meeting, are present at two sites, San José and Santa Rosa (see Map 2), roughly 20 km apart. At each site about 6 000 tons of fish is landed annually. The fishing fleet at each site consists of 60-80 wooden vessels, artisanal type, 3-8 tons, built with local experience without any drawings. The vessels are provided with an inboard motor and use sails whenever winds are favourable.

At both sites a so-called Fish Terminal has been built. This is a fish receptioning, with ice and cold store facilities. Landing facilities and transport facilities for the fish to the Terminal have yet to be provided.

At both places a small fishing community exists, both maintain different customs, including different fishing habits, because they descend from different stages of the preinca culture. Today they still do not mix.

At Santa Rosa fishing is usually a one-day event; vessels depart early in the morning and return in the afternoon, fish is brought in fresh. Fishermen do not move to other fishing grounds when fishing is bad.

At San José fishermen are nomad, moving with the fish, so it is not strange to find San José fishermen at Paracchique, some 450 km north, during some periods of the year. Alternatively, when fishing is bad fishermen start prolonging the fishing cycle, up to 10-12 days, bringing the fish in salted.

2. Physical Site Information

Site information is very scarce, only one sounding profile for San José being available. Presently a survey programme is being carried out.

Both sites fit well into the description of an open continuous beach. A long swell pounds in the year round. Wave periods have been measured, they vary between 10-20 seconds, the predominant period being 14 seconds.

The foreshore, but specially the inshore, is very shallow, having a slope of 1:150.

Waves start breaking as a spilling breaker some 100-400 m from shore.

Littoral drift is quite heavy. Though no reliable information e ists, it should not be less than one million m^3/year. Seasonal beach erosion or accretion can be in the order of 30-50 m.

Spring tide is about 1.50 m, neap tide about 0.50 m.

Winds are generally from the south and south-west, but local changes occur.

Storms are present in the form of high, long waves. 20-second storm-wave periods have been seen.

3. <u>Present Beaching and Launching</u> (slides of activities were presented)

The vessels come in through the surf at the end of a wave-train. After reaching the beach the fish is taken out in baskets, whereafter the vessel is pushed ashore by hand, using rollers, or they wait for a tractor to pull them out with a previously fastened wire around the upper hull (see photographs).

Vessel launching takes place by pushing the vessel into the water on rollers, by hand. Then the vessel is pushed loose from the bottom watching the wave-trains. This requires 10-12 men, and is quite a dangerous operation. It may take several attempts before succeeding in loosening the vessel. Before the last push, occasionally the tractor helps pushing.

4. <u>Proposed Solution</u>

Obviously a fishery harbour development at any of these places would be disastrous. Extremely long breakwaters would be required, and after a short time, necessary dredging would turn prohibitively expensive. Thus initial and maintenance costs would be completely out of proportion with respect to the fish landings.

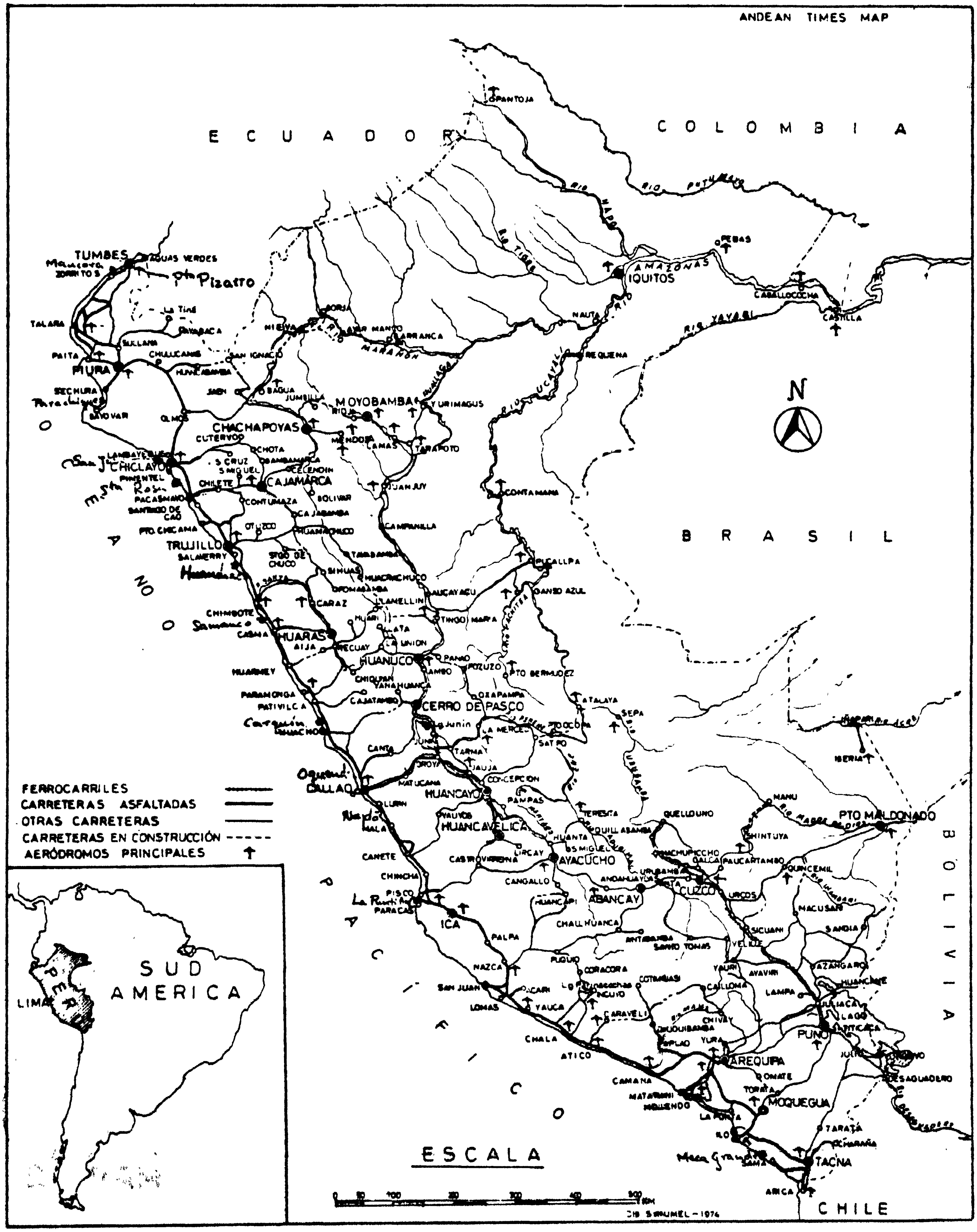
As a possible solution, or rather an improvement of the present situation, a mechanical beaching/launching system has been thought of. A tractor is preferred over a fixed winch arrangement, due to the high number of vessels at each site. A fixed winch arrangement reportedly can provide facilities for only 12-16 vessels. So a number of winches would be required with all the ancillary blocks, wires, etc.

The existing method could be improved by pulling the vessels at the keel. Therefore the keel would probably have to be reinforced with steel strips at both sides, providing a fitting to attach the beaching wire. Possibly vessel stability at the beach could be improved by attaching wooden strips at the bottom, if necessary.

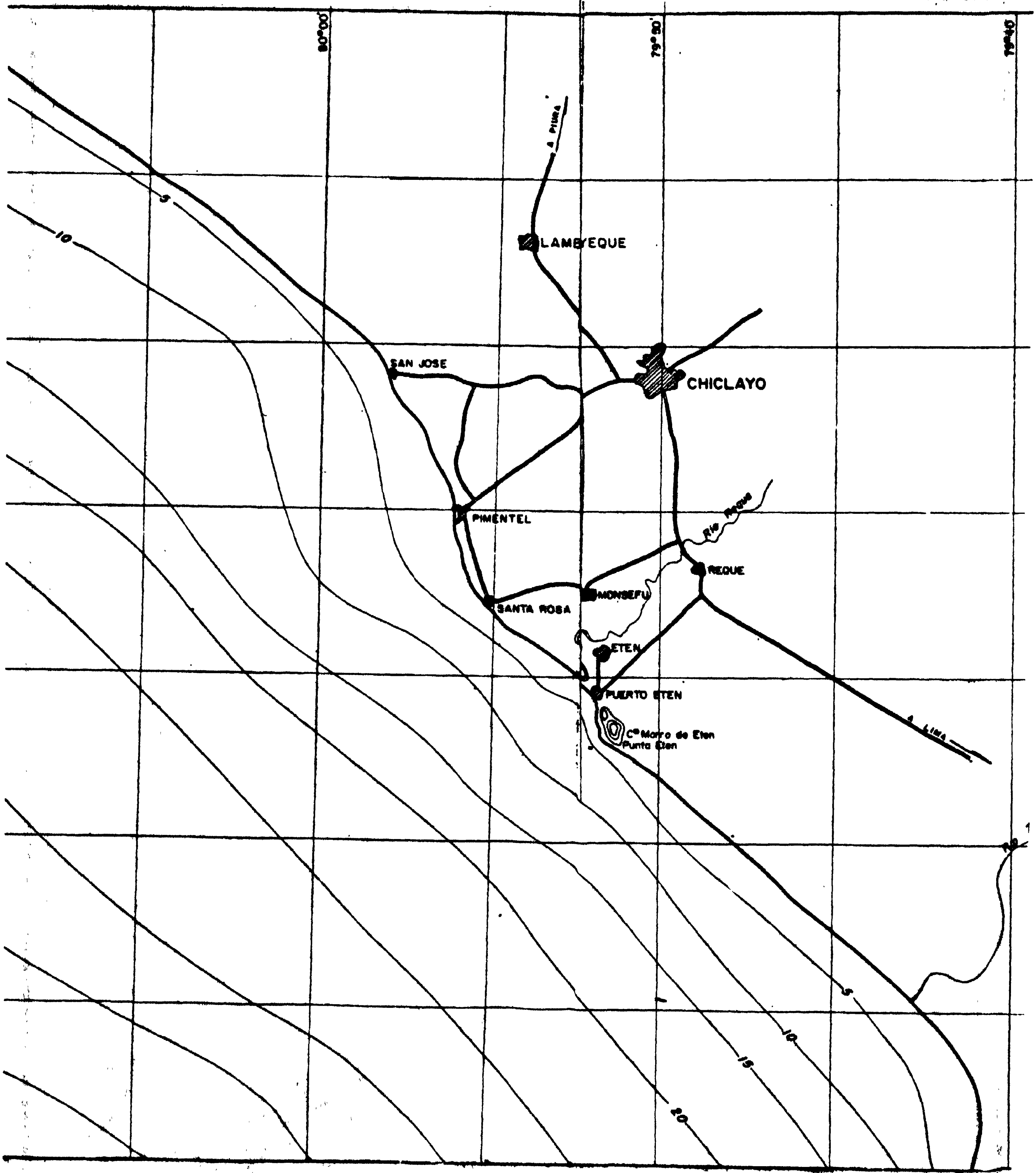
To launch the vessels a winch system based on an anchored main block is less desirable, the block would necessarily be in the surf-zone, and would require a lot of maintenance.

A system is looked for to launch the vessels, perhaps by providing the tractor with a long boom, to push the vessel loose. However, it is estimated that this would require a boom of about 8-10 m length at least.

Transport facilities for fish, water, fuel, salt, etc., could be provided by a tractor-trailer assembly.



Road Map of PERU MAP I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CHICLAYO
SAN JOSE
PIMENTEL
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Punta Eten
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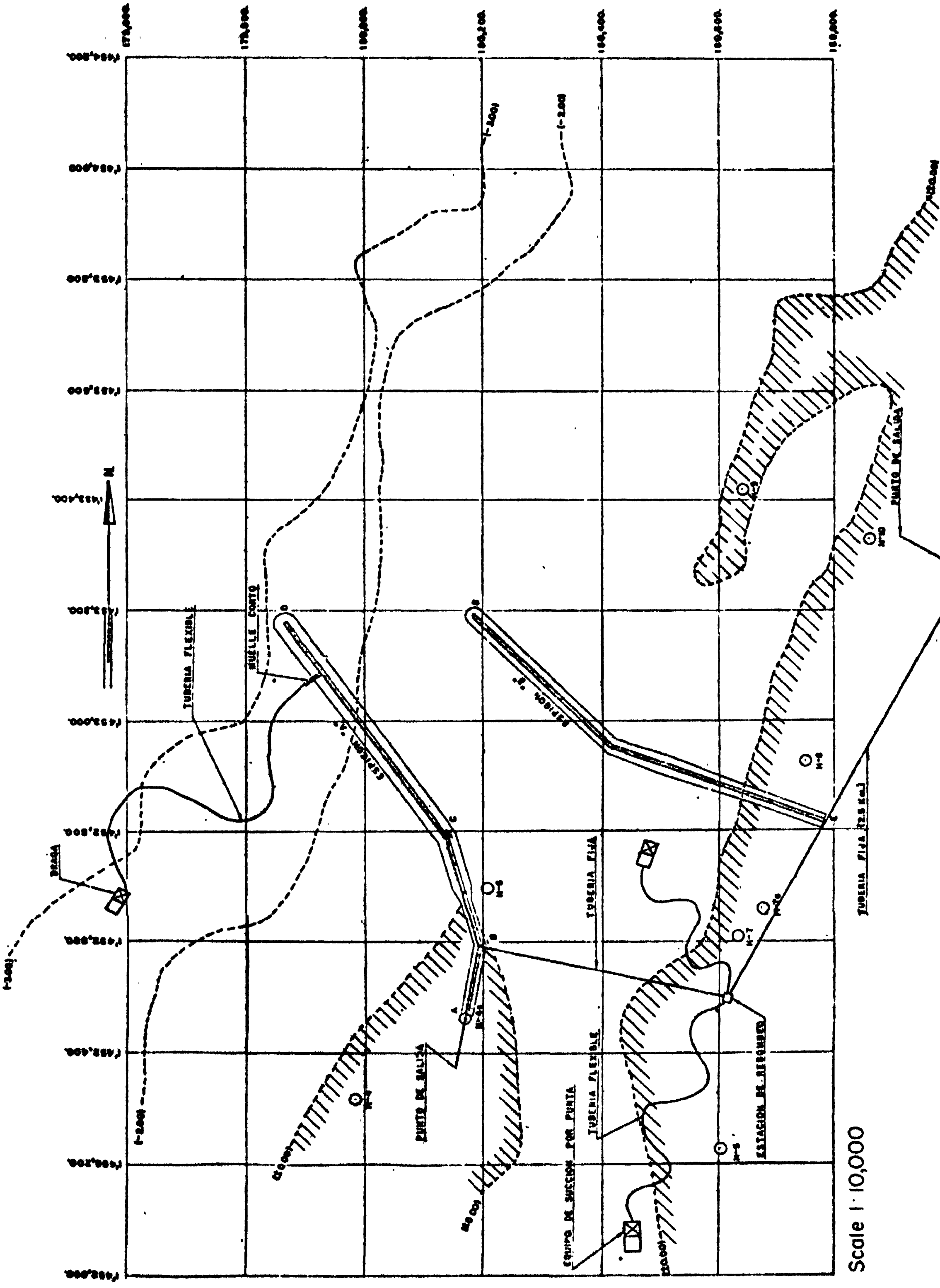
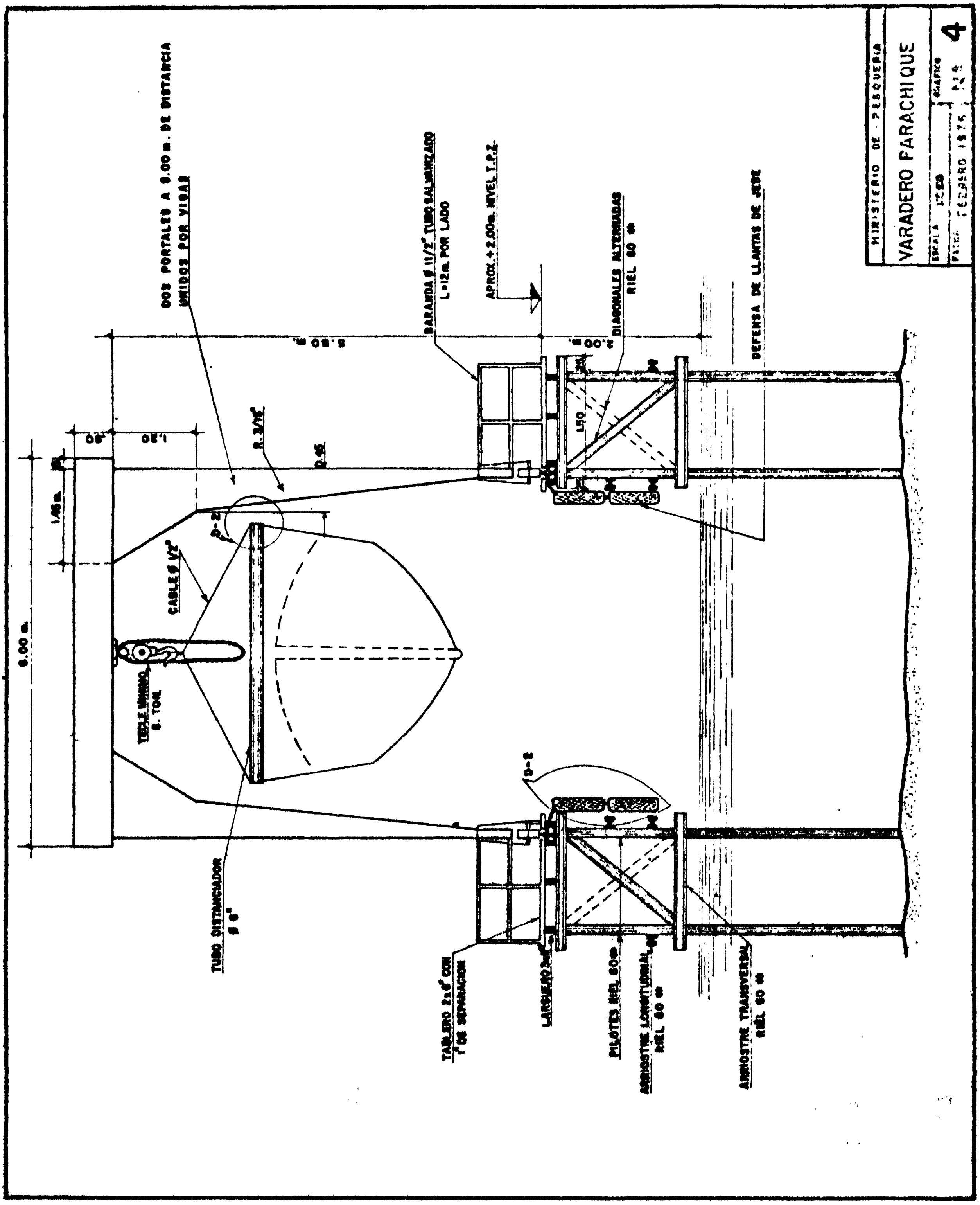
MAP 2



PARACHIQUE - GENERAL OUTLINE SYSTEM JETTIES AND DREDGING

Map 3


DOS PORTALES A 5.00 m. DE DISTANCIA UNIDOS POR VIGAS
BARANDA Ø 1 1/2" TUBO GALVANIZADO L=12 m. POR LADO
APROX. + 2.00 m. NIVEL T.P.Z.
DIAGONALES ALTERNADAS RIEL 60 Ф
DEFENSA DE LLANTAS DE JEBE
6.00 m.
1.45 m.
.50
1.20
0.45
R. 3/16"
6.50 m.
2.00 m.
1.50
D-2
CABLE Ø 1/2"
TECLE MINIMO 5. TON
TUBO DISTANCIADOR Ø 6"
TABLERO 2x6" CON 1" DE SEPARACION
LARGUERO
PILOTES RIEL 60 Ф
ARRIOSTRE LONGITUDINAL RIEL 60 Ф
ARRIOSTRE TRANSVERSAL RIEL 60 Ф
MINISTERIO DE PESQUERIA
VARADERO PARACHIQUE
ESCALA
FECHA FEBRERO 1975
GRAFICO Nº
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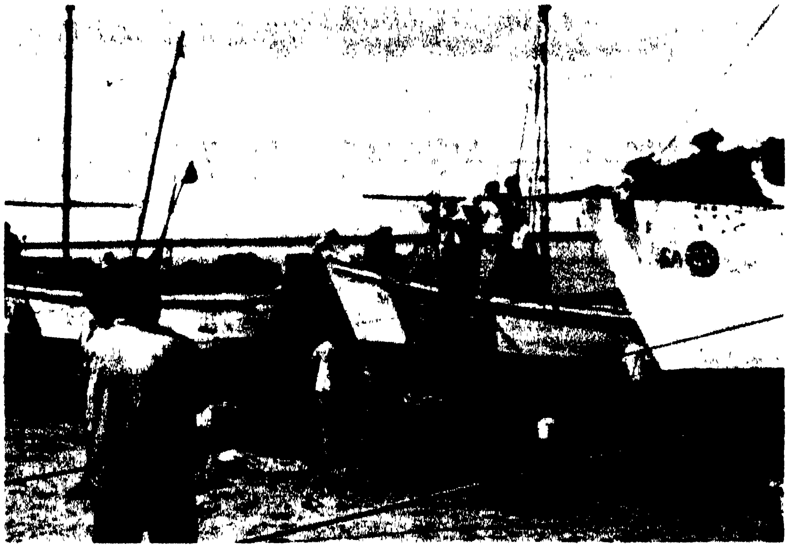
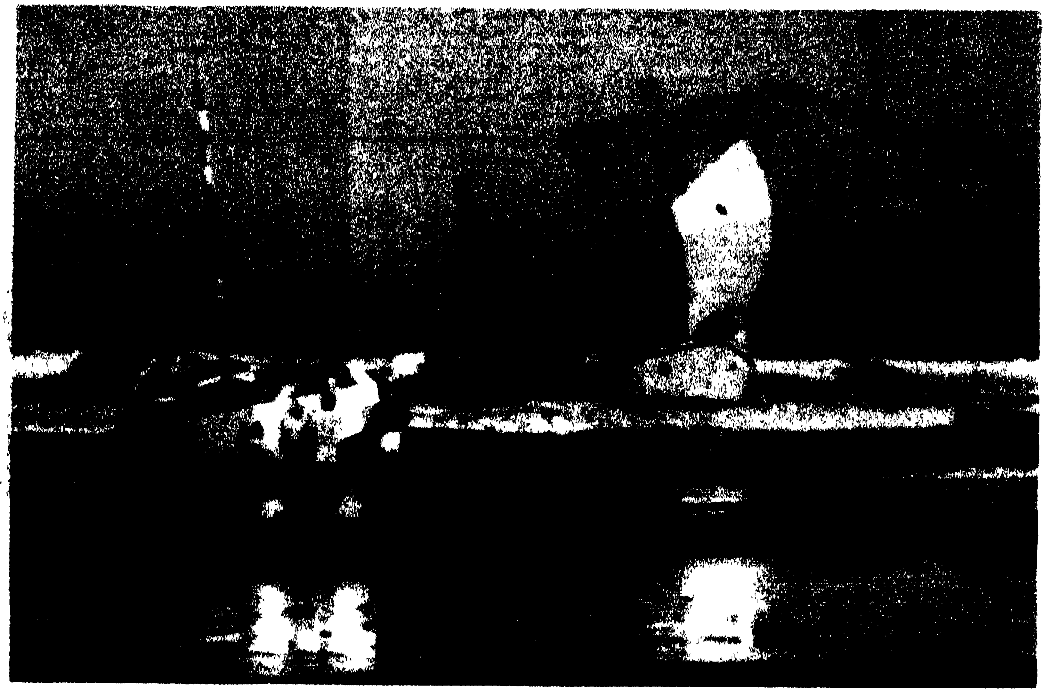


Beach Boats: Santa Rosa, Peru

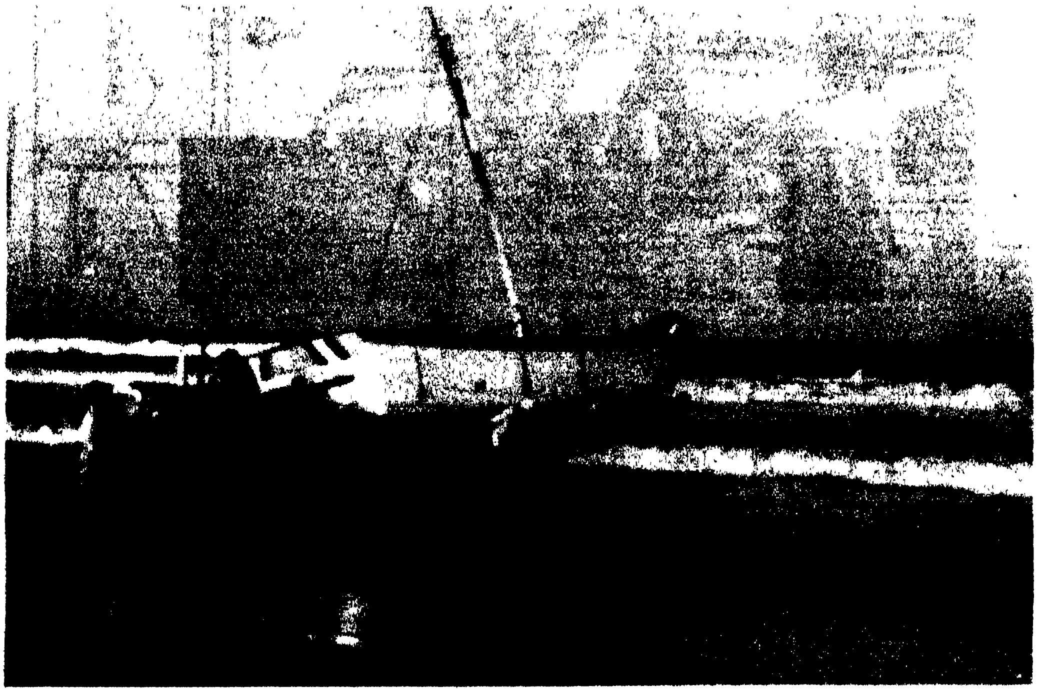
(a) Hauling up

(b) Launching

(c) Unloading



Santa Rosa: (a) Launching and Landing



(b) Illustrating the effort needed for Launching

ANNEX IVg

GOVERNMENT CONSULTATION - ACROSS BEACH OPERATIONS IN THE SMALL-SCALE FISHERY

Paper by N.P. Bhakta, Director, Pre-Investment Survey of Fishing Harbours,
Government of India

Boat Transfer Jetty

1. General

1.1 Small mechanized fishing vessels up to 10 m in length, having a range up to 30 k.ms, require sheltered harbours, about 50 k.ms apart along the coast. Provision of small sheltered harbours at such short intervals would not only prove expensive to construct but also for maintenance, particularly along the east coast of India because of the heavy littoral drift which is in the order of about 1½ to 2 million tons per annum. Any harbour basin constructed along the coast across the littoral zone would soon be filled up with sand if sand is not continuously transferred by mechanical means from one side of the harbour to the other side, to avoid both shoaling up of the approach channel and erosion on the lee side of the harbour.

1.2 After conducting reconnaissance and detailed site investigations at many of the sites along the Indian coast for location and siting of fishing harbours, it is felt that the cost of construction of fishing harbours about 50 k.ms apart and the expenditure involved in maintenance of approach channels and basins of these harbours would be very high on the east coast because of the heavy littoral drift. But at the same time, the acute need to create some facilities at intervals of about 50 k,ms apart for successful operation of small mechanized vessels and fuller exploitation of the inshore area is felt. In order to overcome this conflicting situation, adoption of beach landing of boats was considered. Though there could be several types of beach landing systems, many of them would involve adoption of special type of boats and risky operation of negotiating the boats through surf zone. In order that facilities should be made available for the existing type of boats already in operation and to eliminate negotiating the dangerous surf zone, a system known as "Boat Transfer Jetty" has been designed.

1.3 The function of the Boat Transfer Jetty is to transfer the small mechanised boats up to 10 m in length and indigenous boats from beyond the surf zone in the sea on to sandy beach or sheltered lagoon behind a sand spit a few hours before an impending foul weather or cyclone, as an alternate to a sheltered harbour, involving no expenditure on maintenance dredging. This Boat Transfer Jetty would be a multi-purpose one in view of the fact that fish catches from the boats and ice and fuel to the boats could also be transferred during fair weather when the boats do not like to go on to the land.

1.4 It would be economical to have the Boat Transfer Jetty at places where the slope of the sea bed is steeper than 1 in 50, and where a depth of 2 m at lowest low water is available at about 200 m from the high water line. Since this system would cost about Rs. 21 lakhs and would cater to about 30 boats involving no maintenance dredging as compared to the high capital cost of Rs 3 to 5 crores and maintenance cost of Rs. 50 lakhs for sheltered harbours, the savings would be considerable even if sheltered harbours for small vessels are to be provided 100 k.ms apart along the coast line.

2. Design

2.1 It has been internationally accepted that in order to keep the accretion of sand due to littoral drift to a minimum, it is very necessary that round piles are placed at least 10 m apart with no obstruction such as braces or ties between the piles below high water level, which may obstruct the free passage of littoral drift. Therefore, round piles have

been proposed at about 12 m c/c providing 11 m clear space between piles.

2.2 While designing the above system, it has been assumed that:

(a) soil conditions are typical and the scour depth would not be more than a meter due to seasonal variation of the coast (but the length of the pile is to be arrived at each site, depending on the site and soil conditions);

(b) a wave of amplitude 3 m and period 7 seconds could break on the pile during cyclonic weather, and

(c) the boats would not be hauled up when the wind is blowing at more than 40 km/h and waves are higher than 80 cm.

2.3 The weight of a 10 m boat being only 7 tons, it is proposed to have the boat lifted by two manually-operated winches placed on a trolley and also have the boats transferred to land by manually pushing the trolley with the boat on a 6 meter gauge rail provided on top of the pile.

2.4 The main advantage of this system would be that the facility could be provided for any type of 10-m fishing boats near any fishing village which has no electricity and the operation of the facility would not be affected by power failures which are common before an impending foul weather or cyclone. Further, this being a simple mechanism, it can be easily operated by the fishermen themselves and no special crane operators etc., would be required. It would only involve some nominal maintenance such as periodic cleaning and painting of steel structures, trolley, winches and lubrication of the trolley and winches, which can be attended to by the local fishermen's cooperative organization.

2.5 At places where electricity is available, the winches can be replaced by a 10-ton travelling crane which can haul the boats and travel to the other end carrying the boat. The crane can also be used for transfer of catches, ice and fuel.

3. Structure

3.1 The structure consists of circular reinforced concrete bored piles 90 cm in diameter, spaced at 12 m c/c supporting steel girders. The steel casings of the piles will be left in position up to the lower walk-way level. Crane rails will be welded to the girders keeping the required gauge. In order to avoid torsion in the I Beam, a channel has been added to the top flange as per ISI Standards. The bored piles are designed as independent long columns and the girders as freely supported. Forces due to impact from winds and waves, swaying of the boat, etc., have been accounted for while designing the pile. Sufficient fendering arrangements are included to protect the four piles of the front bay where the boat has to be moored for hauling up. The shore jetty starts beyond highest high water line and extends to a depth of 2 m at lowest low water which would be beyond the breaker zone during fair weather. A transverse concrete platform 15 m wide, 50 meters on either side of the jetty, is laid on the shore end for putting up the boats for landing, beaching and repairs.

Note: The boat trailer with pneumatic tyres may have to be designed by a Naval Architect to see that the boat is properly supported and seated.

3.2 The trolley frame would have four pairs of double flange wheels with facilities for mounting and operating two 5-ton hand-operated winches. It also has four numbers 75 mm diameter rods at four corners of the trolley to dampen the swaying of the boat.

4. Modus Operandi

The fishing vessel will slowly approach one of the two front piles and after moo to the pile it will veer round it into the frontmost bay of the jetty. Two slings

from the winches of the trolley at the top, one in the aft and another in the fore, will be put around the boat. The boat will be lifted up above high water level by manual operation of the winches. Once the boat is above high water, the trolley along with the boat will be pushed towards the shore manually by four fishermen, on the walk-way at the top level, while the boat will be held and guided by four others on the lower level walk-way so that it will not sway. On reaching the platform at the shore end, the boat will be slowly lowered on to a pneumatic wheeled boat trailer. The boat trailer with the boat can be manually pulled to a side, and the boat unloaded from boat trailer at the required point for beaching the vessel. The reverse operation is done for putting the boat into the sea. When the boat is not required to be transferred to land the trolley with winch can lift the catches collected from several boats and have it transferred to land in the same manner explained above. The requirements of ice and fuel in drums can also be carried from land and delivered to the boats mooring to the jetty. If only one or two boats come, their catch can be unloaded on to the walk-way and transferred by head loads as they will be in the order of 50 to 60 kg.

4.2 The approximate time required for single operation would be about 10 to 15 minutes depending upon the weather.

5. Cost Estimates

5.1 The estimate of this Boat Transfer Jetty depends upon the length required and soil conditions at each site. However, a typical estimate for a 204.9 m-long jetty with 17 spans has been prepared, assuming that the average length of piles would be in the order of about 20 m. The cost of a 204.9-m-long jetty would be about Rs. 21 lakhs as estimated in 1974. If an electric travelling crane is used, it may cost about Rs. 25 lakhs.

6. References

(1) IS 456 - 1964 C.P. for Plain and Reinforced Concrete.

(2) ISI - H.B. for Structural Engineers - Structural Steel Beams and Plate Girders.

(3) ISI - H.B. for Structural Engineers - Structural Steel Section.

(4) Shore Protection Planning and Design - Technical Report 4 US Army Coastal Engineering Research Centre - 1966 Edition.

(5) IS 875 - 1964 C.P. for Structural Safety of Buildings - Loading Standards.

(6) IS 800 - 1962 C.P. for use of Structural Steel in General Building Construction.

BOAT TRANSFER JETTY - 204.9 m LENGTH

Abstract Estimate

Sl. No.	Description	Quantity	Unit	Rate	Cost
				Rs.	Rs.
1.	Mobilisation of bored piling equipment (as per experience of Vishakapatnam Outer Harbour Project)		Lump sum		800 000
2.	Providing bored piles of 90 cm dia. and of average length 20 m including reinforcement, casing, driving and finishing, etc.	36	Nos.	22 000	792 000
3.	Providing walk-way 1.0 m wide, 2.0 m above high water level including all steel work, clamps, wooden decking and painting, etc.	405	Sq.m	160	64 800
4.	Providing walk-way at rail level, including all steel work, hand railing, wooden decking, painting, etc.	286	Sq.m	150	42 900
5.	Providing structural steel consisting I Sections, channels and rails, including welding, fixing in position with bolts, nuts, washers, painting, etc.	97	tons	2 500	242 500
6.	Cement concrete (1:2:4) pavement 15 cm thick with 30 cm thick soling	1 750	Sq.m	40	70 000
7.	Steel trolley with two hand-operated hoists of capacity 5 tons each		Lump sum		20 000
8.	Ladders and fenders		Lump sum		7 000
9.	Boat carrier	2	Nos.	3 000	6 000
10.	Miscellaneous and unforeseen items		Lump sum		4 800
			Total		2 050 000
			Say	Rs.	2 100 000

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